Power. and THE ENGINEER

EVERYTHING ABOUT THE GENERATION AND TRANSMISSION OF POWER

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WHEN visiting a steam power plant did you ever notice the piping arrangement?

Could you tell without tracing back to its origin whether a line of pipe carried live steam, exhaust steam, low-pressure steam for heating or feed water for the boilers?

In some alleyway between engine foundations and the building wall of your own plant there may be three or four lines of pipe serving different purposes. Could you send a man to work on any particular line without going along with him to point out just which line you meant?

Would it help you any, in the event of a necessarily hasty shutting of the steam out of a certain line of pipe, if you could send three or four men to close all of the valves on the red line instead of having to point out each individual valve to a rattled helper?

Would it help any if you or any one else employed in the plant could tell whether steam, water, oil or gas was in a pipe as far as the pipe could be seen, and what kind of steam, water, oil or gas or perhaps even electric wiring was inside?

What do you think of the plan of coloring the piping? Would it help out in your plant?

It is being tried in the United States Navy and in several large central power stations, and there is a movement to standardize the colors for each kind of service.

It is sometimes a matter of no small difficulty to trace the individual pipe lines in a system where the space is limited and the units are interconnected, as is frequently the case in large plants.

It is this condition that has led to the adoption in nearly all plants of some method of identification of certain pipe lines and their use.

It is probable that in marine practice the most complicated systems will be found, and in the most restricted quarters.

It is also probable that here the plan of coloring the piping originated after the practice of tagging with letters, numbers and names had proved inadequate.

In this number is presented a color scheme which has been submitted to the Association of Edison Illuminating Companies with the recommendation that it be adopted as standard. The American Society of Mechanical Engineers is also taking up the question, and in general the subject is being given wide attention.

Do the colors meet with your approval? You may possibly have some suggestions to make. At any rate, let us hear from you.

Dalmatian Hydroelectric Plants

Of the Numerous Water-power Plants on the Kerka River in Austria-Hungary, the Largest and Most Important Are the Jarnge and Manojlovac Stations

BY DR. ALFRED GRADENWITZ

The water power of the river Kerka in Dalmatia is one of the most important in Austria-Hungary. This river, from its source at the foot of the Dinara mountains on the Bosnian-Dalmatian frontier, flows in a southwestern direction through extensive moors, in a bed deeply cut into the rocky ground, and terminates in the gulf of Sebenico. Along its course are a number of falls varying between 8 and 27 meters (26 and 88 feet) in hight and the world-renowned Kerka falls, 148 feet high, situated not quite two miles upstream from Scordona.

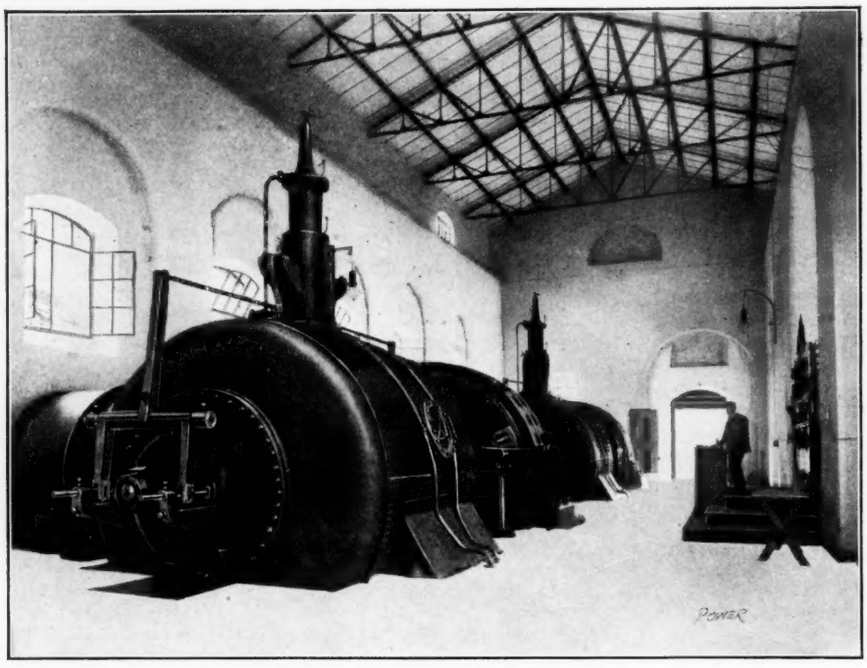


FIG. 1. TURBINE-GENERATORS IN THE JARNGE POWER HOUSE

Those powerful falls have been used since time immemorial to drive primitive water mills, but a number of modern plants have been installed there in more recent times. The first of these, which was erected in 1875 on the Scardona falls, is still in operation, serving by means of piston pumps actuated by two water-column machines to raise the river water up to a reservoir situated 660 feet above sea level, from which both the town and station of Sebenico are fed by gravity through a pipe 6¼ miles long.

The first hydroelectric plant on this river was installed in 1884; it comprises a horizontal Girard turbine driving a 300-horsepower single-phase alternator of 300 volts which supplies current for the operation of mills and other factories as well as for lighting Sebenico through a transmission line 6¼ miles long. This plant was supplemented in 1898 by a second set, a duplicate of the original one.

The first important plant was inaugurated in 1903 in the neighborhood of Jarnge. This plant is of 5000 horsepower total capacity, and comprises two double Francis turbines of 3500 horsepower each, running at 315 revolutions per minute under a head of 80 feet, with a water consumption of 490 cubic feet per second. Each of the turbines is coupled directly through a rigid clutch to a two-phase generator yielding 300 kilovolt-amperes with a power factor of 80 per cent., at 42 cycles per second and a tension of 15,000 volts between terminals. These two sets work in parallel. Fig. 1 is a view in this station.

The transmission line consists of four copper conductors 9 millimeters (0.354 inch) in diameter, carried on brackets attached to poles of impregnated wood, and terminates in the carbide factory situated in the neighborhood of Sebenico, where the potential is reduced by eight single-phase water-cooled oil transformers of 750 kilovolt-amperes capacity each to 48 volts.

The wide fluctuations in the amount of water available (between 500 and 10 cubic meters per second) soon compelled the owners of the plant to supplement it with another plant, the construction of which (like the first one) was entrusted to Ganz & Co., of Budapest. The falls of Manojlovac, where the river, after leaving a lake, forms a loop of about 360 feet head over a length of 1¼ miles, was chosen as a most convenient location of the new power station. The water intake was installed on the lake above referred to, the bottom of the admission sluices being situated about 1¼ miles below the crest of the upper cataracts, which accordingly form a natural weir. Immediately behind the sluices start the flumes, about a mile in length, with a gradient of 2 in 1000 and of 1300 square feet cross-sectional area. Fig. 2 is an excellent picture of the power house and the flumes which bring the water down to it. In order to reduce as far as possible the work of excavation, the generating sets were arranged by pairs, turned with their turbines toward each other, so as to allow the same cutting to serve in the place of two penstocks. The penstock, therefore, comprises two sections, and the supply pipe is accordingly divided into two branches at its entrance into the penstock. Each section of the penstock in turn consists of two compartments fitted with special rakes. Each of these compartments can be shut off by means of a cylindrical gate movable round a horizontal shaft resting in two bearings; the gates are operated by means of hydraulic cylinders.

There are four turbines, built with double-section spiral casings, made of cast steel. In order to eliminate any axial thrust resulting from the considerable head and large output of the turbine sets, the runners have been designed as double wheels, the water being discharged in opposite directions in separate draft tubes. Accurate balancing is obtained by adjusting the slots. Rotary cast-steel adjustable guiding vanes are used to regulate the turbines by means of a steel ring turned round through two cranks by a motor controlled from the switchboard.

In view of the uniform character of the load, no automatic regulation has been found necessary. However, in the event of a turbine running without load, an automatic regulator will come into action when the number of revolutions exceeds by 10 per cent. the normal speed. This is arranged to disengage a dropping lever, coupling the gearing with the belt of the gate-control apparatus, and this will close the turbine gates within three seconds, from the wide-open position.

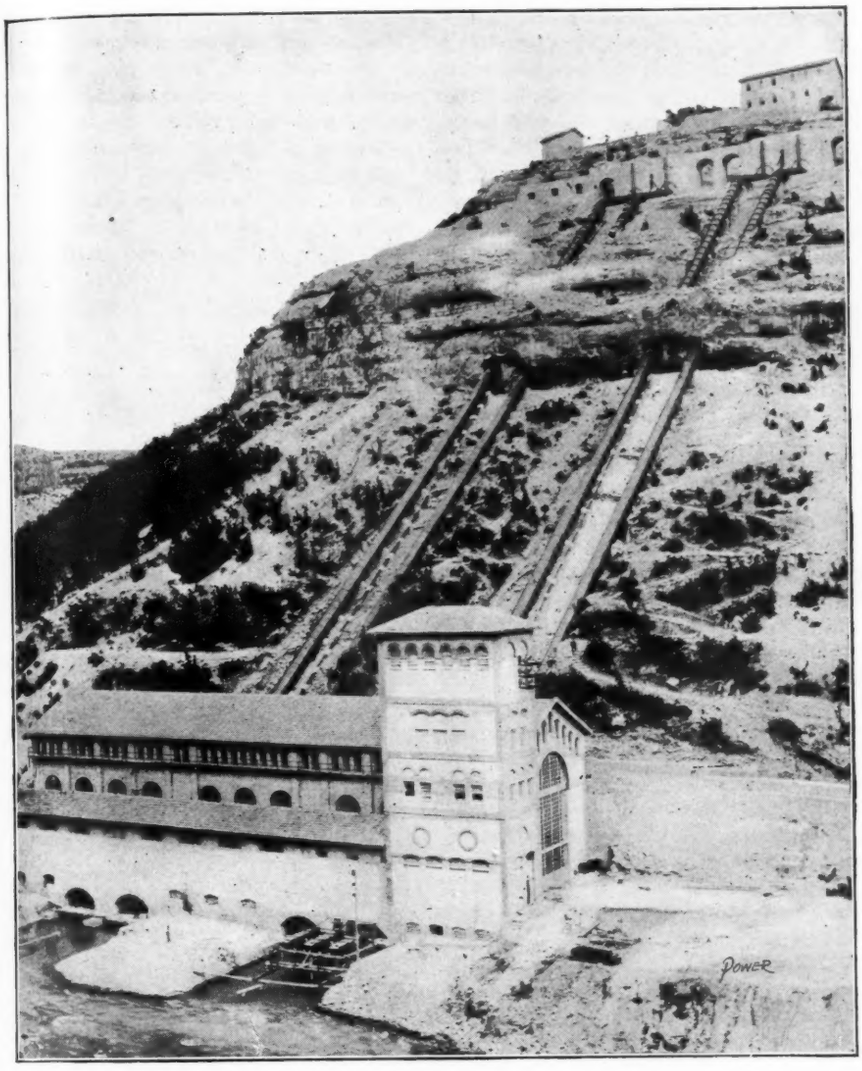


FIG. 2. MANOJLOVAC POWER HOUSE AND FLUMES LEADING DOWN TO IT FROM THE GATE HOUSE

Each turbine shaft runs in two ring-oiling bearings and is coupled to the generator shaft by a rigid clutch.

The generators are 12-pole machines and are designed for the production of three-phase currents at 30,000 volts tension, yielding 5200 kilovolt-amperes at 420 revolutions per minute, with a power factor of 80 per cent.; the frequency is 42 cycles per second, of course. The stator or armature structure consists of two cast-iron housings reinforced by ribbing and provided with ventilation apertures, inclosing the armature core, made up as usual of punched sheet-metal segments, separated by thin paper. The sheet-metal segments are arranged in packages between which are left ventilation channels, and the inductive coils are fitted into the slots formed by the apertures of those segments. Fig. 4 shows one of the generating units.

Special attention had to be paid to the insulation of the armature coils, the generators having to deliver current at 30,000 volts tension. The coils are made up of copper wire of rectangular cross-section wound on forms; insulating micanite insulates each coil from the slot. Small brass blocks are soldered to the terminals of the coils, which are connected together by means of insulated flexible connectors the block terminals of which are screwed to the brass blocks of the coil terminals. Each coil, before being shipped, was tested at a tension of 55,000 volts. The mechanical construction is such that the coils can be removed and replaced without disturbing the field-magnet wheel and its shaft. Fig. 3 shows a group of coils constituting a complete three-phase unit of the armature winding.

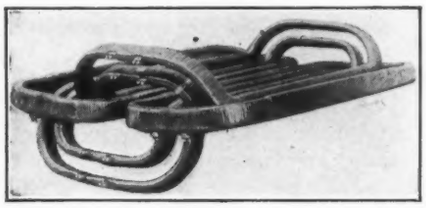


FIG. 3. A THREE-PHASE ELEMENT OF THE ARMATURE WINDING

The field-magnet wheel consists of a cast-steel ring shrunk on the spider. Twelve dovetailed channels, to receive corresponding projections on the heels of the magnet cores, are milled in the outer circumference of the steel ring; the cores are likewise of cast steel, of elliptical cross-section, and are made each in one piece with its pole-shoe. The magnet winding consists of copper strip wound on edge, the convolutions being insulated from one another by thin sheets of press board. The complete magnet wheel is pressed on the shaft by hydraulic pressure of 200 to 250 tons.

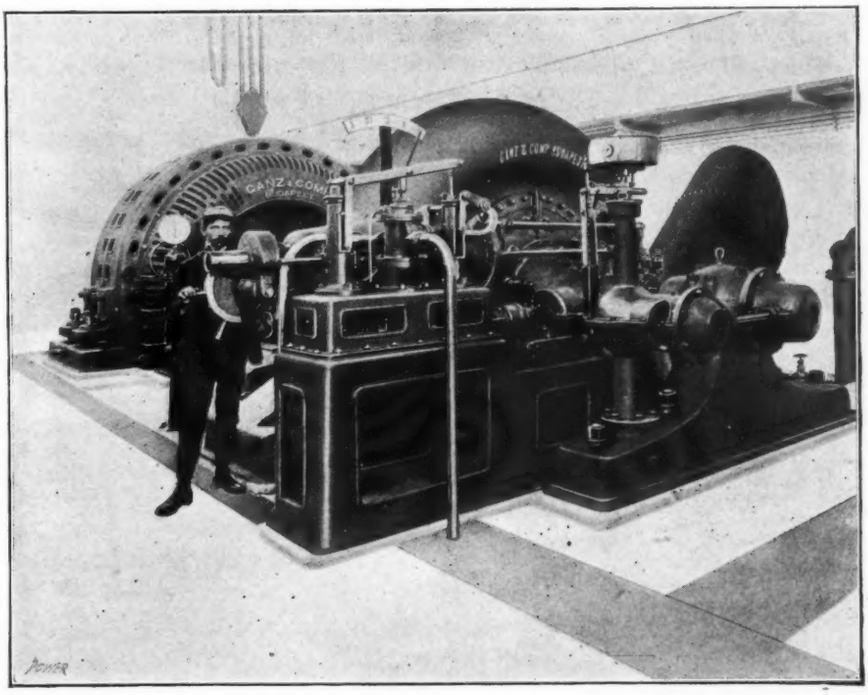


FIG. 4. ONE OF THE UNITS IN THE MANOJLOVAC POWER HOUSE

The weight of the magnet wheel, with the shaft, is 26 tons.

Each generator is provided with its own exciter the armature of which is keyed to the end of the generator shaft; the exciter magnet frame is screwed to a bracket cast on the bearing. The generator shaft rests in two ring-oiled bearings, lined with white metal. Owing to the considerable weight of the magnet wheel and with a view to insure continuity of operation, its bearings have been provided with water-cooling facilities.

The central switchboard consists of four generator panels, one busbar panel and three transmission-line panels. On the generator panel are arranged a hand

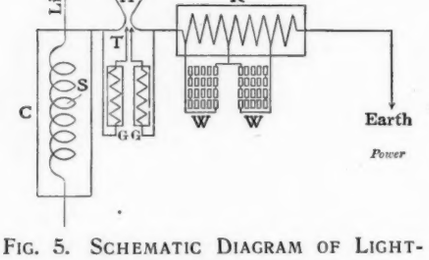


FIG. 5. SCHEMATIC DIAGRAM OF LIGHTNING APPARATUS

rheostat for regulating the field current of the exciter machine, the operating lever for the dynamo switch, a voltmeter, ammeter and wattmeter; the voltmeters for the exciters and a synchroscope for paralleling, with all necessary connections, etc., all this apparatus being in the low-tension circuits. The busbar panel contains three general ammeters, a wattmeter and three automatic switches arranged to open the field circuits of all the exciters if the generator current should rise above a certain limit. The line panels are equipped with the usual ammeters and automatic circuit-breakers for the several lines.

In a special switch room, in a side wing behind the switchboard, are arranged the high-tension switches, built to a considerable extent on the cellular system. Three single-pole oil switches, located in separate cells and operated from the switchboard through a wire rope, are provided for one generator; another cell contains potential transformers. This arrangement is repeated for each of the other generators. The busbars, separated from one another by thin partitions, are arranged above the switch cells, and the generator leads coming from the oil switches are connected to the busbars through section switches which are likewise contained in cells. This arrangement allows the current to be cut entirely off any apparatus for inspection or repairing.

At the point where the wires leave the building, high-tension lightning arresters are located in cells. The design of these arresters was made the subject of great care because of the frequency of violent storms. The arresters are a combination of inductance coils and capacity cylinders, with horn gaps, auxiliary points and earthing resistances with multiple spark-gap cylinders. Fig. 5 represents schematically the arrangement of these lightning arresters, *C* being the capacity cylinder, *S* the inductance coil, *H* the horn discharger, *T* the auxiliary points, *G* a graphite resistance, *W* the spark-gap cylinders and *R* a resistance.

The line then issues into the open air through porcelain tubes and is carried exclusively on wooden poles to the

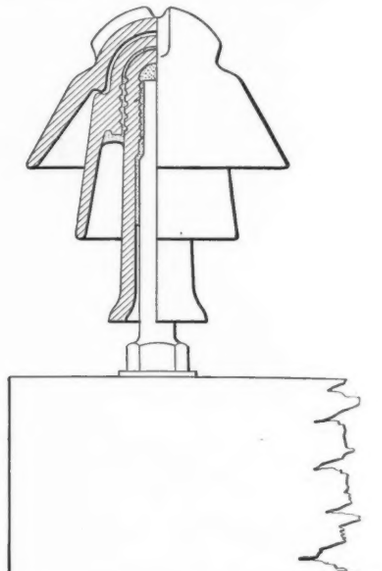


FIG. 6. A 30,000-VOLT INSULATOR

Sebenico carbide factory, 22 miles distant. The six wires are carried on three cross-arms and are spaced 35½ inches apart. Each pole is provided with a cast-iron hood supporting a galvanized-iron wire 0.157 inch in diameter (between Nos. 6 and 7 B. & S. gage) which runs as a lightning-arrester wire alongside the line throughout its length.

Feed Water Heaters and Economizers

Effect of Oil and Scale Forming Matter in Open Heaters. Saving from Using Economizer. Live-steam Feed-water Heaters and Purifiers

BY WILLIAM F. FISCHER

Open feed-water heaters are of a type in which exhaust steam and cold water are brought into actual contact, the water space being open to the atmosphere.

By means of suitable devices (usually trays or pans) the water is broken up into spray, or thin sheets so that it will readily absorb the heat of the steam.

OIL IN OPEN HEATERS

Where an open heater uses exhaust steam contaminated by grease, trouble with the boilers is almost certain, unless the grease is extracted before mingling with the feed water. This grease will, if allowed to enter the boiler, settle down on the fire sheets, which in time may become overheated, and bulge or blister, as the grease prevents the water from reaching the iron.

The success of an open heater depends largely upon the efficiency of the oil separator or grease extractor used in connection with it, as after the steam is condensed it is practically impossible to separate the grease from the water. In this case, chemical treatment of the feed water becomes necessary.

If the steam contains considerable grease it may be necessary to install separate exhaust-steam purifiers and oil filters to cleanse the steam before using it. This means an additional expenditure of money for apparatus on which the plant must earn an income.

SCALE IN OPEN HEATERS

Open heaters utilize the water of condensation from station drips, etc., except such as may be allowed to go to waste, and as the cost of feed water is a big item in cities this feature should be considered. If the feed water contains a large amount of mineral matter and scale-forming substances, provision is made to purify the water before it enters the heaters.

Chemical treatment of the feed water renders the scale-forming substances and corrosive acids harmless. The purification of the feed water also takes place, to a large extent, in the open heater. Such sediment and scale-forming substances as are precipitated at 210 of 212 degrees Fahrenheit, are deposited on the trays and in the settling chamber in the heater to be removed from time to time. The sulphates of lime and magnesia require from 290 to 300 degrees Fahrenheit for complete precipitation, and where water containing these ingredients is to be used it is best not to trust

altogether to an exhaust-steam heater, for a live-steam heater and purifier may be used to good advantage.

A considerable amount of air and carbonic acid gas is released from solution in the feed water when heated. Such gases are especially active in attacking moist iron and steel and frequently cause severe pitting and corrosion if allowed to enter the boiler, but in the open heater they escape through the heater vent to the atmosphere.

Fuel Economizers

The heat rejected by the boiler furnaces may be utilized to heat the feed water for the boilers or to heat water for manufacturing purposes by installing an economizer between the boilers and the chimney.

Of the several methods of deriving benefit from the waste heat units this is the most expensive but desirable under certain conditions, as the gases going to the chimney carry off, according to good authorities, on an average of from 15 to 30 per cent. of the heat units contained in the fuel, and in some cases more.

In average power-plant practice, however, these gases may be discharged at temperatures ranging from 450 degrees to 550 degrees Fahrenheit, representing a loss of from 20 to 30 per cent., which may be taken as a more conservative figure for central station work.

The advantage of always having a large supply of feed water at a high temperature renders the economizer particularly adaptable for stations where great and sudden variations of load have to be met from time to time. Economizers also take the place of additional boiler heating surface.

Well designed economizers receiving proper care and attention and installed where the conditions warrant show a favorable balance, after deducting the necessary fixed charges for depreciation, etc. But if an economizer is not kept clean, satisfactory results cannot be obtained, as the efficiency of heat transmission through the tubes is more or less seriously impaired.

In well designed power plants, using water-tube boilers, the flue gases may never be much better than 500 degrees Fahrenheit, whereas in industrial plants the temperature of the waste gases from ovens, kilns, furnaces, etc., may reach as high as 1500 degrees or more; therefore, in order to estimate the saving from an economizer for a day's run, the initial temperature of the entering gases must be known, also the temperature of the feed water entering and leaving the economizer as well as the volume of water passing through it.

The economizer also precipitates many of the impurities found in feed waters, and because of the slow motion of the water passing through the tubes, these precipitates fall to the bottom to be blown or washed out.

The sulphates of lime (commonly called gypsum or plaster of paris) form the hardest kind of scale, sometimes being as hard as porcelain. A temperature of 290 degrees Fahrenheit is necessary for complete precipitation of all the lime; therefore, if the feed water reaches this temperature in the economizer the lime may be entirely precipitated before reaching the boilers. Sulphate of lime is precipitated in the form of heavy crystals that fasten themselves to the sides of the boiler or other heating surface, and are quite difficult to remove.

In determining whether economizers should be installed or not there are several points to be considered, i.e., the cost of economizer plant, erected and ready for operation; cost of additional building space to house economizers; amount of exhaust steam available for the purpose of heating feed water in exhaust heaters; initial temperature of feed water, whether the feed is taken from a hotwell, exhaust heater, or cold supply; rise in temperature due to economizer; reduction in boiler-heating surface made possible by installing economizer; extra cost of stack or forced-draft apparatus necessary to compensate for the loss of draft due to economizers; and interest, depreciation, cost of operation, taxes and insurance. The cost of operation should include the cost of mechanically operating the tube scrapers.

Where the boilers are run at their normal rating and the temperature of the flue gases is low, an economizer reduces the temperature still lower and impairs the draft by increasing the resistance between the boilers and chimney, making it necessary, in some cases, to install a higher chimney or forced-draft apparatus to do the work of the natural draft. Decreasing the normal temperature of the flue gases from 550 degrees Fahrenheit to 350 degrees Fahrenheit, for instance, reduces the draft approximately 25 per cent.

Small plants not subject to overload conditions seldom employ economizers as feed-water heaters where sufficient exhaust steam is available for that purpose.

Some small plants, however, are subject to severe overloads, and as high-priced men are not generally employed to see that proper methods of firing are followed, economizers in such cases may pay larger dividends.

Live-steam Feed-water Heaters and Purifiers.

Live-steam heaters, as the name indicates, use steam directly from the boilers to do the heating. The usual type is fitted with removable trays. The water to be purified discharges into the upper pans, and overflows into the second tier, and so on to the bottom when it is fed to the boilers. The heater is provided with a blowoff to remove such sediment as may settle on the bottom of the shell.

The live steam comes into contact with the cooler water and heats it to the temperature necessary to cause precipitation of the impurities in the feed water.

The trays are removable for cleaning and are so designed in some types that the water while overflowing adheres to the under side in thin sheets, depositing the precipitated impurities upon both sides.

As the steam and water are in more intimate contact on the under side of the pans than on the top, the greatest part of the deposit collects on the under side.

Live-steam heaters are chiefly used for the purpose of purifying by heat treatment feed water containing the sulphates of lime and magnesia alone, or in connection with the bicarbonates. As these sulphates are almost entirely precipitated at a temperature corresponding to 50 pounds gage pressure, this is the lowest pressure that should be used to obtain the desired results.

The purifier should be of ample size as the precipitation of the sulphates is gradual, requiring more or less time for completion.

An approximate rule, given by good authorities, is to allow one-half square foot of lime-catching surface to each boiler horsepower. As certain gases are given off in the purifier when the water is heated, some means should be provided for their removal. As there is no appreciable gain by heating feed water by live steam taken direct from the boiler, live-steam purifiers are usually used in connection with exhaust-steam heaters, the exhaust steam heating the water to about 210 degrees Fahrenheit before it enters the purifier.

The purifier should be located about 2 feet above the water line in the boilers so the feed water will flow from the purifier to the boilers by gravity.

The purifier should also be provided with a suitable bypass so the water may be fed directly to the boilers when necessary to cut out the purifier for cleaning or repairs.

The feed water is pumped into the purifier against full boiler pressure. The gravity feed main connecting the purifiers with the boilers should be provided with a check valve, and carried below the water line of the boilers. All branch pipes should be taken off from this main and, rising to the boilers, enter each drum below the water line. Each branch pipe should be equipped with a stop valve and a check valve, although a better arrangement would be to place the check valve between two stop valves for use when repairing or cleaning the check valve, should the disk bind or stick.

All feed-water heaters, economizers, live-steam purifiers and similar apparatus should be provided with suitable bypass pipe connections.

Standard Colors for Station Piping*

Suggestion for Color Scheme Which Will Stand the Test of Time and Use. Striking Effects Made Secondary to Durability and Distinctiveness of Coloring

BY J. P. SPARROW

The increase in size and the complexity of the equipment of our modern power plants has naturally resulted in complication of the piping systems. It has been made evident that some means of identifying and readily tracing the piping and direction of flow of the contained fluids is both convenient and necessary for the operating engineer.

In our smaller stations of earlier design we had steam, water, oil and air piping, usually a common system for all units. In our present stations we have steam piping for superheated and saturated steam, and of various pressures; we have water piping for house service, boiler feed, jackets, cooling coils, ash sprinkling and fire service, both salt and fresh; oil piping, both gravity and high pressure, and of different qualities for different service. We have air piping for pneumatic tools, blowing boilers and general pressure service.

Piping systems are usually designed on the common or the unit basis, with the latter often interconnected. Where space is limited, the piping systems of a large power station become very much complicated and involved, making the tracing of the individual lines a matter of difficulty.

This condition has led to the very general adoption of some scheme of tagging, lettering or coloring the different piping systems to make easier their identification or to indicate their use. Many of these schemes have been based on the practice of the United States navy, where, on board ship, the most complicated systems are found.

Correspondence with prominent designing and operating engineers resulted in agreement without exception as to the need of proper means of identification; the question has been submitted to the American Society of Mechanical Engineers with recommendation for action and adoption of a color scheme which may be accepted as standard.

The desirability of a standard scheme is evident from a comparison of the several practices tabulated. At present there is wide variation in the system adopted, schemes having been evolved on the one hand with a view to durability of coloring, and on the other, that the color be suggestive of the use.

On the whole, the first scheme seems the most desirable. All colors except black change, more or less, in use from temperature, atmospheric influence and handling.

The requisites of a color scheme for identification purposes are, in the writer's opinion:

That colors should be permanent.

That tints should be avoided, primary colors being used as far as possible.

That where variation in use occurs the distinction should be made in variation of band, fitting or flange coloring retaining the body color as distinctive of the class.

That the piping receiving the highest temperature should be the darker colors.

How far the existing schemes meet the above specification may be seen by comparison of the practices of the large power houses and the United States navy. It will be noted that in many cases durability has been made secondary to striking color characteristics; this in the writer's opinion is undesirable; touching up of the lighter colors made necessary by wear and tear is impracticable and the necessity for frequent complete repainting involves comparatively large expense.

Coloring of piping is not all that is necessary to make easy the quick handling of a system in time of trouble. Stenciling at frequent intervals (30 to 50 feet) showing the use of the line and arrows showing the direction of flow have been found to be of great assistance at times of emergency, and also of great help when construction work is being carried on during regular station operation; the opening or closing of a valve by mistake may mean serious interruption of service; proper means of identification make such mistakes almost impossible.

As a suggestion for a standard color scheme, the writer has modified slightly the scheme in use at the Waterside station No. 2 of the New York Edison Company. This coloring has stood the test of time and use, and while open to possible criticism from an esthetic point of view, has given entirely satisfactory results from the standpoint of durability and distinctiveness of coloring.

The scheme is not presented as being complete and covering all the requirements of power-plant use, but while retaining the general scheme, modifications of banding, flange and fitting coloring may be made to suit individual requirements.

*Paper presented before the Association of Edison Illuminating Companies.

How to Get Promoted Quick

The old timer was in again—his plant does not run on Saturday afternoons and he likes to come up here; says it reminds him of the old roundhouse gang and the stove committee.

"Say," says he, "you mind me tellin' you about old man Gage and the feller that burned his boiler? Yes; well, here's another one the old man got off once that was plumb funny.

"I was a kid timekeeper for Gage way back in war times, 'fore you was born, I guess, and one day in comes a kind of a cross between a dude and a smart Alec, about twenty-five years old, who wore pretty good clothes while his mother cleaned coaches out in the yard.

"'Mister Gage,' says he, 'I want a job of firing. I hear the 116 is goin' on the Granger branch and I'd like to fire her.'

"Now the 116 was a nice, little passenger engine that hauled two cars and a snap to fire, and the old man kept her for boys that had been sick or something like that; a child could keep her hot. So he turns to the chap and says in a kind of a come-on voice:

"'You don't want the 116; it's too hard work, and there ain't much chance for promotion on the branch—a bright, ambitious young man like you don't want to fire forever, do you?'

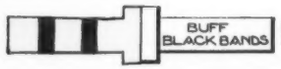
"'No, sir,' says the softy, 'I want to fire till I get the hang o' the thing and then run.'

"'Jest so, jest so,' says the old man, thoughtful like, 'I knowed you was ambitious, and I'll tell you what you do. You go and enlist and then you can fire, and run too, right away!'"

The following is a useful glue for fastening leather to iron: Best ground glue two parts and acetic acid one part. Glue dissolves when acid is heated. Mix well together and apply.

SUGGESTION FOR STANDARD COLORS FOR POWER STATION PIPING.

No1 STEAM TO ENGINES, TURBINES, BOILER CROSSOVERS, BOILERS AND MAIN HEADERS.



No2 ALL STEAM LINES NOT INCLUDED IN CLASS NO. 1.

No3 STEAM EXHAUST LINES.

No4 STEAM DRIP LINES, INCLUDING DRIP RECEIVERS, DISCHARGES TO BOILERS, BLOWDOWNS, REDUCER LINES AND MANIFOLDS.

No5 GRAVITY DRIP DISCHARGES FROM MANIFOLD TO RECEIVER FROM RECEIVER TO HEADER, HEADER TO BOILERS AND BLOWDOWNS AND REDUCER LINES.

No6 ALL FRESH WATER PIPE FROM METERS TO INLET NOZZLES FOR F. W. HEATERS, WATER JACKETS, OIL COOLERS, STEP BEARING PUMPS, OR TO ANY POINT WHERE TEMPERATURE OF WATER CHANGES OR MIXES WITH OTHER WATER.

No7 WARM FRESH WATER MAINS FROM OUTLETS OF JACKETS AND COOLING COILS TO F. W. HEATERS AND HOT WELLS TO PUMPS TO FEED WATER HEATERS.

No8 FEED WATER PIPE FROM HEATERS AND PUMPS TO BOILER DRUMS.

No9 BLOWOFF PIPE DRIPS FROM WATER COLUMNS AND ALL LOW PRESSURE DRIPS, ROOF LEADERS, OVERBOARD DISCHARGES FROM HOT WELL PUMPS.

No10 ALL PIPES CARRYING SALT WATER EXCEPT FIRE LINES.

No11 BEARING OIL TO AND FROM OVERHEAD TANKS TO ALL BEARINGS AND SMALL SERVICE TANKS AND CAN FILLING VALVES.

No12 CYLINDER OIL PIPING THROUGHOUT STATION FROM BARREL TANKS TO PUMPS, TO OVERHEAD TANKS TO CYLINDERS.

No13 RETURN OIL PIPES FROM ALL BEARINGS AND CATCH-ALLS TO FILTER TANKS.

No14 FIRE LINES, PRIMING LINES AND ALL OTHER SERVICE USING WATER FROM FIRE PUMPS.

No15 PNEUMATIC SYSTEM.

Supplement to *Power* and *The Engineer*, April 26, 1910. Vol. 32, No. 17..
Accompanying Article "Standard Colors for Station Piping."

TABULATION OF COLOR SCHEMES FOR PIPE LINES.

No. 1. Bureau of Steam Engineering, U. S. Navy.

Pipe Lines.	Colors of Pipe.	Colors of Bands, Couplings, Flanges, Valves or Fittings.
Steam, supply	White	Black
Steam, exhaust	White	Red
Feed pump, suction (fresh water)	Gray	Black
Feed pump, delivery (fresh water)	Gray	Red
Steam pump, suction (salt water)	Green	Black
Steam pump, deliveries and flushing pipes (salt)	Green	Red
Hydraulic, supply (fresh)	Blue	Black
Hydraulic, exhaust (fresh)	Blue	Red
Main, auxiliary and all other drains, sounding pipes and air vents (salt)	Pink	Same
Fire service (salt)	Red	Same
Flood pipes for magazine and trimming tanks (salt)	White with red diamond	Black
Pneumatic service	Black	Same
Ventilating supply	Yellow	Black
Ventilating exhaust	Yellow	Red

No. 2. Pa., N. Y. & L. I. Ry. Co., Long Island City, N. Y.

Pipe Lines.	Colors of Pipe.	Colors of Bands, Couplings, Flanges, Valves or Fittings.
Steam, high-pressure (superheated)	White	Same
Steam (saturated)	Bright red	Black
Exhaust from auxiliary apparatus	Yellow	Same
Drips from superheated steam, including the Holly system and connection to boilers	Bright red	Same
Holly system connections from saturated steam	Bright red	Black
Low-pressure drips	Yellow	Same
Blowoff	Maroon	Same
Boiler feed from pumps to boilers, including heaters, economizers and their connections	Black	Same
Fire-protection system	To match adjacent structural steel	Same
All other water lines	Blue	Same
Crank-case oil between engines and separators	Slate	Same
All other oil lines	Brass unpainted	Same
Air	Green	Same

No. 3. Boston Elevated Railway Company.

Pipe Lines.	Colors of Pipe.	Colors of Bands, Couplings, Flanges, Valves or Fittings.
Steam, high-pressure	Black	Same
Steam, low-pressure	Orange	Same
Exhaust steam, to floor line	Color of engine	Same
Exhaust steam, below floor line	Buff	Same
High-pressure drips to Holly receiver or traps	Black	Red
Hot-water returns from Holly receivers and high-pressure traps to boilers	Green	Red
Low-pressure drip to traps	Orange	Black
Discharge from low-pressure traps	Buff	Black
Cold feed water, to primary heaters, toilets, sinks, etc	Blue	Same
Hot feed water, primary heaters to boilers	Green	Same
Fire service	Red	Same
Salt-water intake	Slate	Black
Salt-water discharge	Slate	Red
Cylinder oil	Yellowish brown	Black
Engine oil	Yellowish brown	Red
Air	White	Same
Gas	Slate	Same

No. 4. Commonwealth Edison Company, Chicago, Ill.

Pipe Lines.	Colors of Pipe.	Colors of Bands, Couplings, Flanges, Valves or Fittings.
Live-steam lines	Medium yellow	Same
Exhaust-steam lines	Dark green	Same
Blowoff lines	Black	Same
Boiler-feed lines	White	Green
House service, city-water lines	Blue	Same
Fire-protection water lines	Dark red	Same
Compressed-air lines	Pea green	Same
Lubricating-oil lines	Light steel	Same

No. 5. Williamsburg Station, Brooklyn Rapid Transit Company.

Pipe Lines.	Colors of Pipe.	Colors of Bands, Couplings, Flanges, Valves or Fittings.
High-pressure steam	White	Same
Exhaust steam	Yellow	Same
Feed water	Light slate	Same
Oil	Red vermilion	Same
Water	Red Tuscon	Same
Condenser water	Green	Same

No. 6. Edison Electric Illuminating Company of Brooklyn.

Pipe Lines.	Colors of Pipe.	Colors of Bands, Couplings, Flanges, Valves or Fittings.
Steam piping	Yellow	Same
Exhaust steam	Drab	Same
Cold water, H. P	Dark red	Same
Cold water, L. P	Dark green	Same
Hot-water feed	Dark blue	Same
Oil	Bright red	Same

No. 7. Waterside Station, New York Edison Company, New York.

Pipe Lines.	Colors of Pipe	Colors of Bands, Couplings, Flanges, Valves or Fittings.
Steam, high-pressure to engines, boiler crossovers, leaders and headers	Black	Brass
All other steam lines	Buff	Black
Steam, exhaust	Orange	Red
Steam, drips including traps	Orange	Black
Steam-trap discharge	Green	Black
Blowoffs, drips from water columns and low-pressure drips	Slate	Red
Drains from crank pits	Dark brown	Blue
Cold water to primary heaters and jacket pumps	Blue	Red
Feed water, pumps to boilers	Maroon	Same
Hot-water mains, primary heaters to pumps, and cooling-water returns	Green	Red
Air-pump discharge to hotwell	Slate	Black
Cooling water, pumps to engines	Blue	Black
Fire lines	Vermilion	Same
Cylinder oil, high-pressure	Brown	Black
Cylinder-oil, low-pressure	Brown	Green
Engine oil	Brown	Red
Pneumatic system	Black	Same

No. 8. Waterside Station No. 2, New York Edison Company.

Pipe Lines.	Colors of Pipe.	Colors of Bands, Couplings, Flanges, Valves or Fittings.
Steam to turbines, boiler crossovers, U-bends, leaders and ring header	Black	Brass
All other steam lines	Buff	Black
Steam, exhaust	Buff	Green
Steam-drip lines, including drip receivers, discharges to boilers, blow-downs, reducer lines and manifolds, but not risers	Orange	Black
Gravity-drip discharge from manifold to receiver, from receiver to header, header to boilers and blow-downs and reducer lines	Orange	Permanent vermilion
Blowoffs, drips from water columns, and all low-pressure drips, roof leaders, overboard discharges from hotwell pumps	Lead	Black
All Croton water from meters to inlet nozzles for feed-water heaters, water jackets, oil coolers, step-bearing pumps, or to any point where water changes temperature or mixes with other water	Dark blue	Permanent vermilion
Warm Croton, from jackets and cooling coils to feed-water heaters, also hotwell to pumps and feed-water heaters	Dark blue	Black
Feed water from heaters and pumps to boilers	Pompeian red	Same
Fire lines, ash-hopper service, priming lines and all other service using water from fire pumps	Permanent vermilion	Same
Cylinder oil throughout station, from barrel tanks to cylinders	Tan	Permanent vermilion
Bearing oil from overhead tanks to all bearings, small service and canfilling valves	Tan	Black
Bearing oil from all bearings and catch-alls to filter tanks, and from filters to pumps and overhead tanks	Tan	Light green
Pneumatic system	Black	Same

No. 9. The Philadelphia Electric Company.

Pipe Lines.	Colors of Pipe.	Colors of Bands, Couplings, Flanges, Valves or Fittings.
Steam lines	Olive green	Same
Exhaust lines	Black	Same
Oil supply, gravity system	Yellow	Red
1000-pound accumulator	Bright red	Red
150-pound turbine governor	Bright red	Black
Compressed-air system	Brown	Same
Electrical conduit	Blue gray	Same
Oil return	Yellow	Black

Testing Water Wheels after Installation*

The Importance of Operating Water Wheels at Their Maximum Efficiency. The Alden Dynamometer and Some Results Obtained by Its Use at the Holyoke Testing Plant

BY PROF. C. M. ALLEN†

In the last few years there has been a growing demand for brake tests of water wheels after installation, the object being to determine the horsepower and in many cases the efficiency of the wheels, under actual running conditions, as well as to ascertain whether the wheels are up to their guaranteed rating.

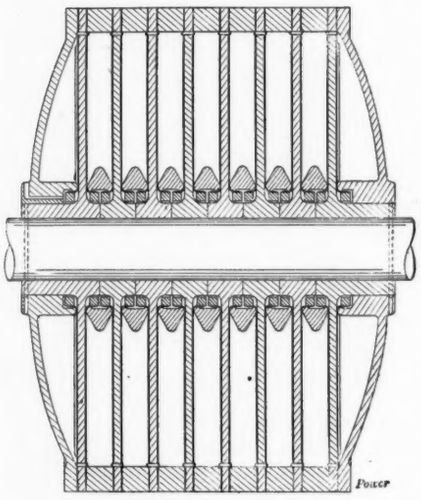


FIG. 1. SECTION THROUGH ALDEN DYNAMOMETER

The Holyoke testing flume is the only place in the United States where commercial tests of water wheels are made. For purposes of comparison under similar conditions these tests serve their purpose well and their influence has been great in the development of the modern efficient turbine; but, however well a wheel may show up under these tests, it may or may not give equally good results after installation.

The efficiency of water wheels under actual working conditions has a very direct bearing upon the conservation of natural resources, and every inducement should be offered to keep that efficiency high. The water wheel as it is, leads all other prime movers in efficiency. Under ideal working conditions of the steam engine, gas engine and steam turbine, the water wheel has at least three times as good an efficiency as the best of these. If, therefore, by increasing the efficiency of the water wheel, even by a small percentage, we are able to get just so much more power from the same amount of water used, this clearly has a direct bearing on the question of conservation.

When wheels are installed in hydro-electric stations, and apparently do not show the power and efficiency guaranteed, the question naturally arises, why should a brake test be thought necessary? This may be answered in several ways. In the writer's opinion, an electrical test should be sufficiently accurate and reliable in determining the output of the wheels if properly conducted. The reason for making a good many brake tests in the past has been to settle disputes between the hydraulic and the electrical interests, relative to the guaranteed operation of the plant. The majority of water-wheel builders in this country are not willing to abide by the results of an electrical test unless the wheels show up to the guaranteed power by such tests. The generator manufacturers are also unwilling to assume that the generators are low in efficiency, or that their testing apparatus is unreliable. The use of the brake for actually determining the horsepower output of the wheels at the generator coupling is satisfactory to all parties concerned, for the simple reason that the apparatus is very much less complicated and more easily understood by everyone. Moreover, the accuracy of the brake can be determined on the ground while under test, as the calibration of the machine can be made at that time, and there is no possible chance for a serious error. In other words, the brake test is the simplest, most accurate, and most direct method of measuring power, and is universally recognized as the standard.

In making electrical tests there are many more chances for errors to creep in than in making the brake tests. Ordinarily several electrical instruments are needed, which should be carefully calibrated before and after tests. These are liable to become changed in transit to the station. Many times they are used under different conditions of temperature, of magnetism, of connection, etc., than when calibrated, and the total results are liable to error on account of the number of instruments to be read, thus bringing in errors which may be more or less cumulative.

It was with the idea of meeting this demand that the Alden asborption dynamometer was developed and built in large sizes. The principle of the dynamometer is so familiar that only a brief description will be given. It is a form of prony brake, and usually consists of several smooth, circular, revolving, cast-iron disks (see Fig. 1), keyed to the shaft which transmits the power; a nonrevolvable housing having its bearings upon the hubs of the revolving disks and a pair of thin copper plates in contact with each cast-iron disk, the plates being integral with the housing. Through a system of piping, water under pressure is circulated through chambers between the units, each consisting of a disk and

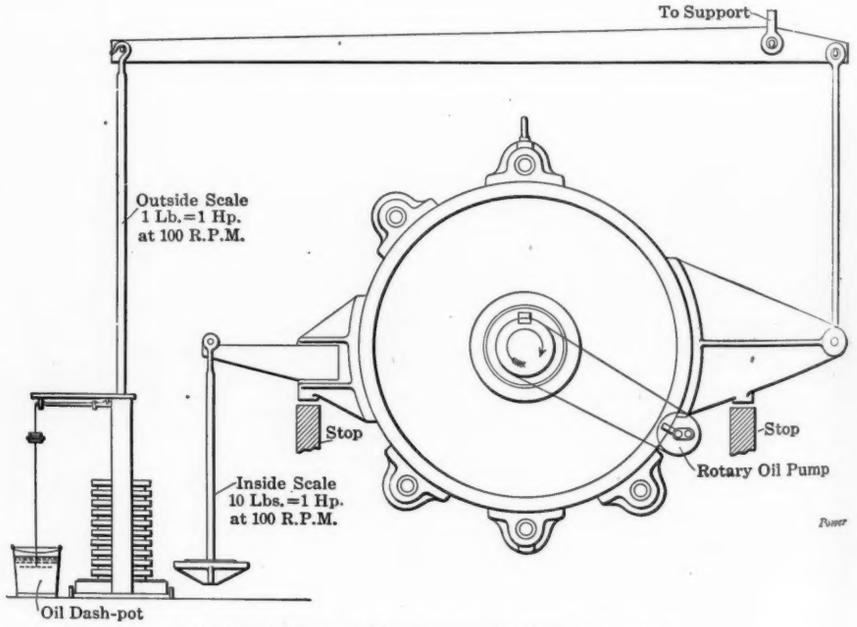


FIG. 2. WORKING PRINCIPLES OF DYNAMOMETER

*Abstract of paper to be delivered before the American Society of Mechanical Engineers, Boston, April 27, 1910.

†Professor of hydraulic engineering at Worcester Polytechnic Institute.

its copper plates, and between the outer plate at either end and the wall of the housing. The water pressure is regulated by hand or by an automatic valve. Another system of piping circulates oil for lubricating the surface of the copper plates next to the revolving disks. In the large-sized machines, oil is impelled by a belt-driven pump mounted on the housing, enters the chambers at the circumference and is forced along the radial grooves of the disks to the hub, and completes its circuit through hose connections to the pump.

The power required to drive the pump is measured with, and included in, the power of the dynamometer, for the pump is bolted to the housing, and the driving tension in the belt which operates the pump tends to rotate the housing in the same manner as does the internal friction of the disks; this makes a calibration to determine the power used by the oil pump unnecessary.

When the dynamometer is in use, water passes through the chambers of the housing and between the several units of plates and disks, and by its pressure tends to force the copper plates against the sides of the revolving disks, the resulting friction offering a resistance to the rotation of the disks. The resistance to turning thus imposed is balanced by the weighing apparatus.

The power transmitted from the wheel under test tends to rotate the housing. This tendency is counteracted by platform scales, and the housing is kept from rotating, beyond the prescribed limits, by stops on either side of a lever arm bolted to the housing. The weighing apparatus by which the power absorbed is measured is delicately adjusted on knife-edge bearings. There are two sets of lever scales, which may be called the outside and the inside scales. The outside indicates one horsepower for one pound weight per 100 revolutions per minute while the inside scale indicates one horsepower for 10 pounds weight per 100 revolutions per minute. The outside scale serves not only to assist in balancing the load, but also to take the weight of the housings from the bearings on the hub of the revolving disks. See Fig. 2.

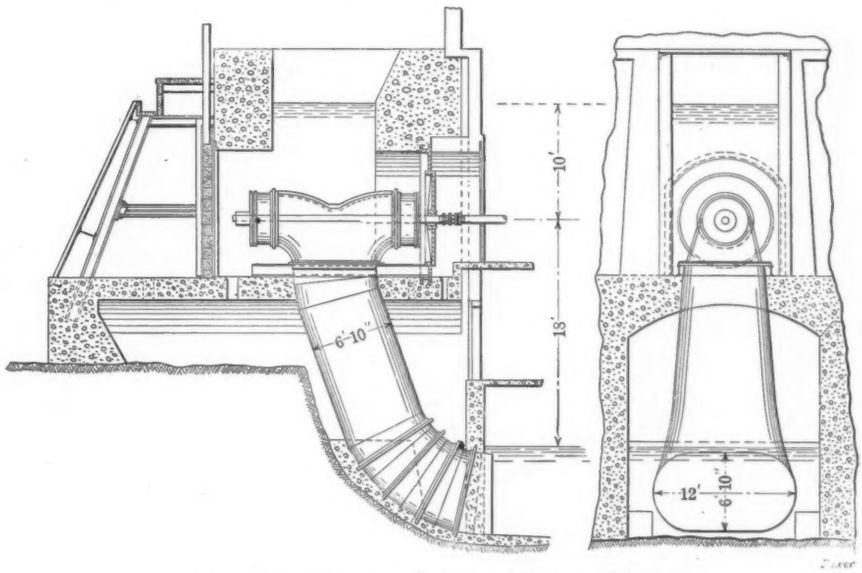


FIG. 5. SETTING OF A PAIR OF 36-INCH WHEELS

It is possible to take from the bearings not only the weight of the dynamometer, but also the weight of the shaft. Several tests have recently been made on wheels developing over 2000 horsepower, where the entire weight of the dynamometer and shaft (about 13,000 pounds) was counterbalanced so nicely that the nearest required running bearing was that of the water wheel some 7 feet away from the dynamometer. Fig. 3 shows an Alden dynamometer rigged ready for testing.

To calibrate the dynamometer requires simply the determination of the distance from the center of the shaft to the knife-edge bearing of the lever rod, the ratio of the overhead lever, and the standardization of the platform scales. Besides this, it is necessary to determine the initial load on the dynamometer due to the unbalanced effect of the piping, fittings, arms, stops, lever and scale pan. This should be done at the time of test and with the apparatus as used. The usual method employed (see Fig. 4) consists in disconnecting the shaft coupling and raising the dynamometer so that parallel irons can be placed under the shaft; by means of a strut under the knife edge on the end of the lever the correct weight of the initial load is then obtained by the use of platform scales.

The largest dynamometer built at present consists of four 60-inch disks and has a power-absorbing capacity of 1500 horsepower at 100 revolutions per minute, or about 3000 horsepower at 200 revolutions per minute.

The capacity of the dynamometer is limited by the amount of heat that can be transmitted through the copper plates.

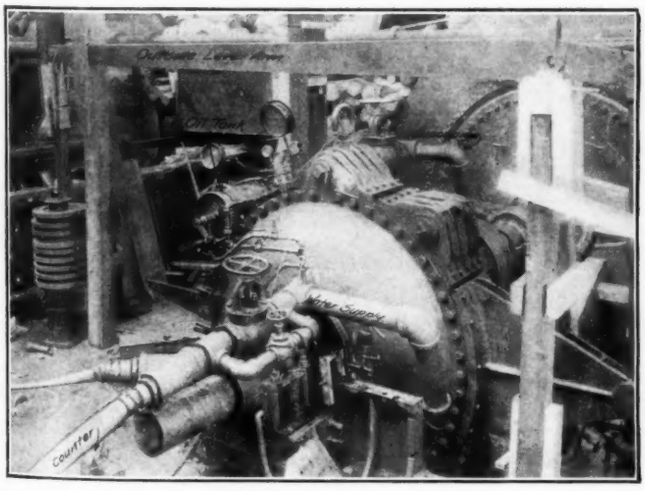


FIG. 3. DYNAMOMETER RIGGED FOR TESTING

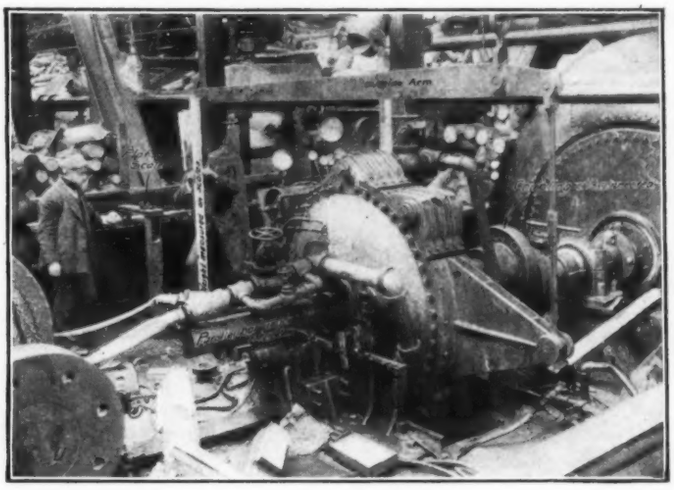


FIG. 4. CALIBRATING DYNAMOMETER AFTER TEST

This depends upon the range of temperature and the amount of the circulating cooling water. The capacity is also affected by the kind of lubricating oil used. A cheap grade of cylinder oil has been found satisfactory, and a system of forced lubrication is essential to smooth operation.

A series of tests has recently been made at the laboratories of the Worcester Polytechnic Institute to determine the relative heat-transmitting properties of copper sheets just as they are received from the rolling mill, and also of similar sheets electro-copper-plated. These tests were made with a view to increasing the capacity of the dynamometer. The apparatus used consisted of two double-disk Alden dynamometers with the rotating cast-iron disks removed.

The dynamometers were set up so that the spaces normally occupied by the revolving disks were piped to the steam main. Plugs were removed from the top and bottom of these spaces so that all air and condensed steam would be removed. Circulating water was supplied at the bottom of the casings and taken out at the top, both the circulating water and condensed steam being collected and weighed. Thermometers were inserted in the steam line next to the dynamometer and in the water-supply line, also in the discharge of the circulating water and of the condensed steam. Several tests of five minutes' duration were run on each. The accompanying table gives results of these tests.

The results were all reduced to a common basis, namely; the B.t.u. transmitted through 1 square foot of copper sheet per minute per 50 degrees difference in temperature of circulating water. The dynamometer containing the copper-plated sheets showed an increased heat transmission of more than 30 per cent. over that of the untreated. A probable explanation of this phenomenon is that when the sheets are electro-copper-plated, the copper is deposited in small globules and the actual surface not only is increased but is made rougher; this tends to mix up the water currents, bringing more new water in contact with the copper.

In the actual operation of these dynamometers, the heat is generated on a thin film of oil directly against one side of the copper and the water passes over the surface on the other side, carrying off the heat generated. It is a well known fact that more heat is transmitted through copper than can be readily carried off by the water, and any increase in surface in contact with the water gives a corresponding increase in capacity. As the capacity of these dynamometers depends upon the heat-transmitting power of the copper sheets, it is clear that this capacity can be increased 30 per cent. by the use of electroplated sheets.

Owing to the system of continuous forced lubrication, the dynamometers are capable of holding their maximum load for any length of time. A dynamometer recently used held a load of from 2000 to 2300 horsepower during a series of tests of over eight hours duration.

To give an idea of the actual running conditions sometimes found, a test in one plant showed that the wheels were giving the power called for by the contract, but that if they had been run at 200 instead of 225 revolutions per minute, the power would have been increased from 2000 to 2300 horsepower; thus showing a waste of 300 horsepower and a correspondingly lessened efficiency. On another test it was found, that when the

PLAIN VS. ELECTROPLATED COPPER SHEETS

	Plain Copper Sheets.	Electro-plated Copper Sheets.
Average temperature of entering water	44 deg. F.	44 deg. F.
Average temperature of exhaust circulating water	100 deg. F.	100 deg. F.
B.t.u. per square foot per minute per 50 degrees difference in temperature of circulating water	467	610
Increase in percentage		30.8

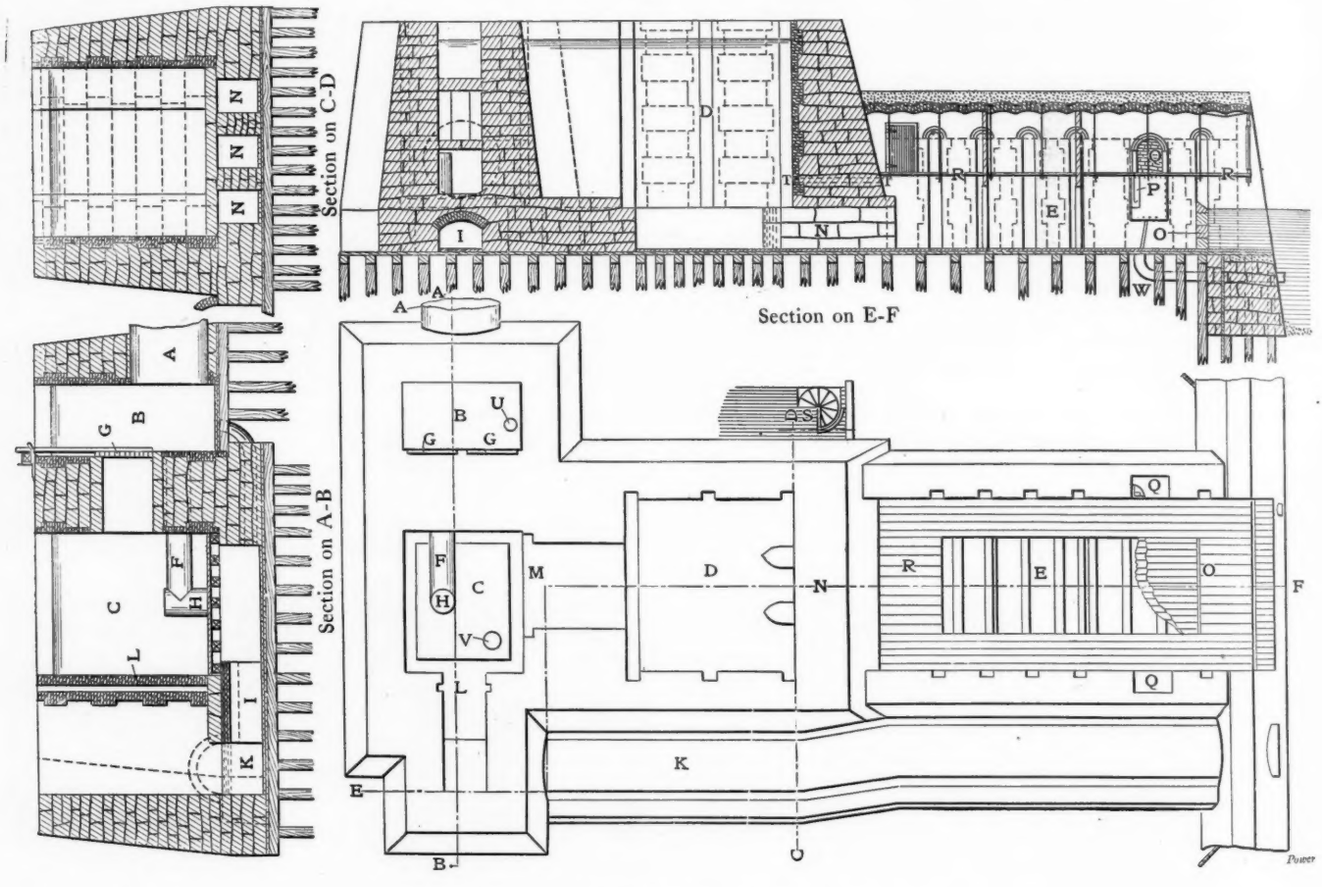


FIG. 6. GENERAL LAYOUT OF HOLYOKE TESTING PLANT

wheels were running at the guaranteed speed, the power and efficiency were between 30 and 40 per cent. lower than they should have been. Removing the entire load only slightly increased the speed.

Incidental to the brake testing of water wheels, considerable information has been obtained regarding the efficiency of large bevel gears, such as are commonly used in transmitting power from vertical wheels in low-head installations. About a year ago, a series of tests were made to determine: first, the horsepower delivered to the horizontal generator shaft from the two vertical wheels; second, the horsepower of the individual vertical wheels. By subtracting the former from the sum of the latter, the loss due to the bevel gears and bearings was obtained. The tests were conducted in the above order so as to get the output at the generator coupling with gears running normally. Then the gears were removed and the individual vertical tests were made.

The total horsepower was approximately 700. The driving gear was of the ordinary wood-mortise type, 6 feet 5 inches outside diameter with 68 teeth, 14 inches wide, and meshing with a cast-iron pinion which had 48 teeth with a planed-tooth outline. At full load the loss in the gears was 3.5 per cent. and 3.4 per cent. for each of the two separate units, or the efficiency of the horizontal-shaft, vertical wheel-gear drive was about 96.5 per cent. The gears were well lubricated with a thick grease.

About nine months later it was necessary to test one of these same units in exactly the same manner. The loss in gears this time was a trifle less, the tests giving 3.1 per cent. As a matter of fact, the gears were running smoother at the last test, having had nine months more of service. When the first tests were made, the plant had been running less than a year.

All of the information obtained concerning the loss due to bevel-gear drives, leads the writer to conclude that if gears are properly designed, set up and operated, and are not overloaded intermittently or continuously or left to care for themselves, they should show an efficiency of from 95 to 97 per cent.

In Fig. 5 is shown a setting for a pair of 36-inch wheels operating under a head of 28 feet, at a speed of 200 revolutions per minute. The wheels are set 3.3 diameters apart and the draft tube changes from a circular to an oval cross-section with a constantly increasing area, and discharges horizontally into the tailrace. In this particular installation, the velocity of the departing water from the draft tube was found to increase materially the working head on the wheels. The results of the brake tests made after installation, checked with the Holyoke tests computed for the same head at full gate. It may also be of interest to note that the generator tests made immediately following also checked with the brake tests.

Within the past five years there have been made over 100 complete brake tests of wheels at different plants in all of the New England States and most of the eastern Atlantic States. Most of the leading makes of wheels have been tested in this manner, and under heads varying from 10 to 200 feet. Information derived from this experience confirms the following general statement.

That the performance of low-head turbines of diameters up to about 36 inches, as computed from the Holyoke tests, should be attained after installation; that turbines greater than 36 inches in diameter should show better results after installation than those computed from the Holyoke tests, the amount of difference increasing with the diameter of the turbine.

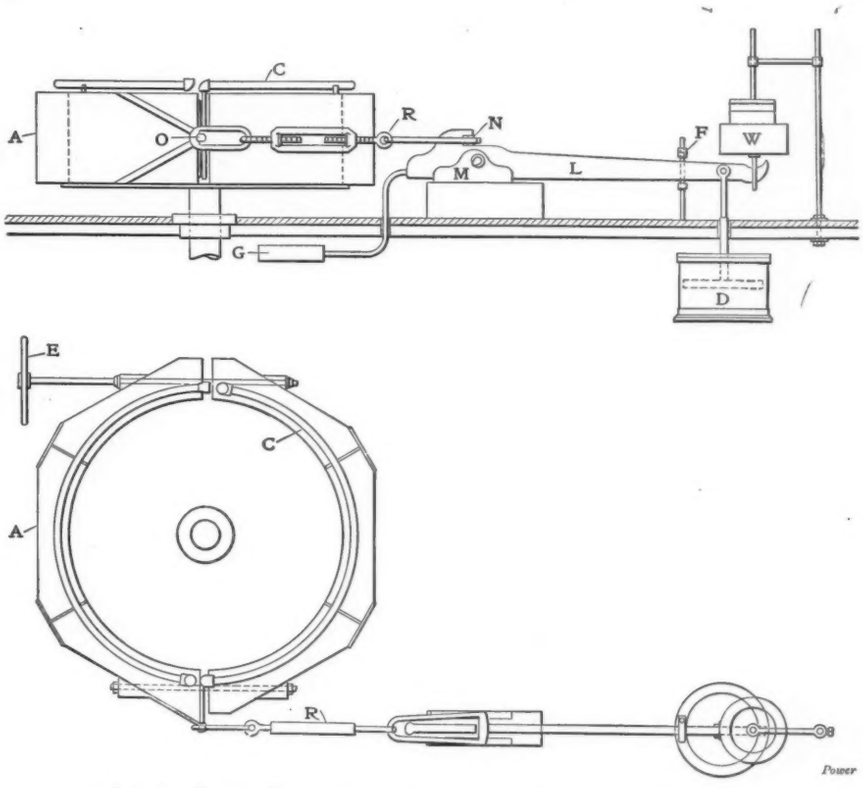


FIG. 7. PRONY BRAKE WITH BALANCING LEVER AND WEIGHTS

THE HOLYOKE TESTING PLANT*

An outline diagram of the building and equipment is shown in Fig. 6. The flume is covered by a large brick building which houses all apparatus required in testing any wheels of the turbine type within the capacity limit. Water is led from the feeding canal through the 9-foot pipe or penstock *A* into chambers *B* and *C* between which are located the main head gates *G G*, controlled from the floor above by a separate turbine. The wheel pit *D* discharges into the chamber below and thence under the arches *N* into the tailrace *E*. The crest of the standard measuring weir is at *O* and this discharges into the lower canal. Two sides *L* and *M* of the chamber *C* are lined with stop planks. The former acts as a waterway and regulates the hight of the water when turbines of low heads are under test; while the latter is used when the wheels under test require an empty wheel pit *D*, as in the case of scrolled wheels.

Turbines are firmly bolted to the wheel-pit floor in the manner designed for final operation. With vertical-shaft wheels, the shaft passes through a properly alined bearing in the floor above and to the end is attached the dynamometer or brake used for absorbing and measuring the power developed by the wheel. For the occasional testing of a horizontal shaft wheel, the shaft passes through a bearing in the masonry wall which separates the wheel pit from a special pit at its side where the dynamometer and its accessories are controlled. The tailrace and weir (with or without end contractions) are constructed so that the empirical formula of Francis can be used. The depth of the tailrace below the crest of the weir is about 6 feet, in order to reduce the velocity of approach, and the water may be entirely withdrawn considerably below the level of the lower canal by an outlet into the sewer *W*. The water level of the tailrace is accurately measured by a hook gage placed

*The following description is not included in Mr. Allen's paper. For the information and accompanying illustrations we are indebted to G. E. Quick.

in a recess *Q* at the side of the tailrace and sunk some 3 feet below the level to facilitate the making of observations. Winding stairs *S* lead from the main dynamometer floor to the platform just above the tailrace level, and at the side of these stairs are two gages; one giving the level of the tailrace by a ball-float valve, and the other, the level of the water in the wheel pit as shown in a glass tube connected to it. The two are so arranged that their difference can be easily read and the effective head on the wheel determined.

In the first few years of the new flume the power was absorbed and measured by a metal-band friction brake, clamped on a brake wheel which was keyed to the turbine shaft above the main floor. Difficulty was experienced in lubricating the metal surfaces, and consequently the metal band was displaced by a set of wood blocks fitted to the periphery of the wheel, shown in Fig. 7. The force tending to rotate this band with the brake wheel is transmitted through the linkage *R* and from a horizontal to a vertical direction by the bell-crank lever *L*. The unbalanced weight *W* together with the effective lever arm and speed is a measure of the power absorbed; *D* is a dashpot to lessen the vibration of the brake. Lubrication of the friction surfaces is by means of several jets of water or soap suds from the pipe *C*.

So many tests have been made at this flume that the system is nearly perfect. Four men only are required for a test: a man to read the hook gage determining the weir level, another on the stairs *S*, Fig. 6, to read the effective head, an attendant constantly at the adjusting wheel *E* of the dynamometer, to keep the lever *L* balanced, and the chief of tests who reads the speed counter and keeps the log. Readings are taken simultaneously at each post of observation at the minute stroke of an electric bell connected to and controlled by a central clock.

The first test is to find the maximum starting torque or effort of the wheel at full gate opening. This is obtained by clamping the dynamometer to hold the wheel stationary while the weights *W* are changed until an exact balance is obtained. Torque is then computed from *W* and the length of lever arm through which it acts. The wheel is then allowed to revolve and a weight selected which permits a balance at a safe maximum speed. This load is maintained constant until several minute observations have been taken, then the balance weight is slightly increased and several full sets of minute readings again taken. The load is increased in small increments in this way until a value is obtained for which the efficiency of the wheel is a maximum. A similar series of observations is made for four or five different gate openings, and the results give the full performance of the wheel.

The work of making the computations is greatly facilitated by several sets of screws transferring the weir measurements into quantity of water by means of the well known Francis formula.

The maximum capacity of the flume is about 15,000 cubic feet of water per minute at a head of 18 feet. With large capacity wheels the head is materially lowered so that about 300 horsepower with a head of 14 to 15 feet is near the maximum limit. A number of dynamometers of different capacity are in use, for the dynamometer is under better control if its frictional surface is roughly proportional to the power absorbed.

Tests of Tile Roof Furnaces*

Recently, at the engineering experiment station of the University of Illinois, J. M. Snodgrass, assistant professor of mechanical engineering, directed two series of tests of a boiler having a tile-roof furnace. Each series consisted of four tests of ten hours' duration. The object of the tests was to compare the performance of the boiler when operating with two types of furnace roof.

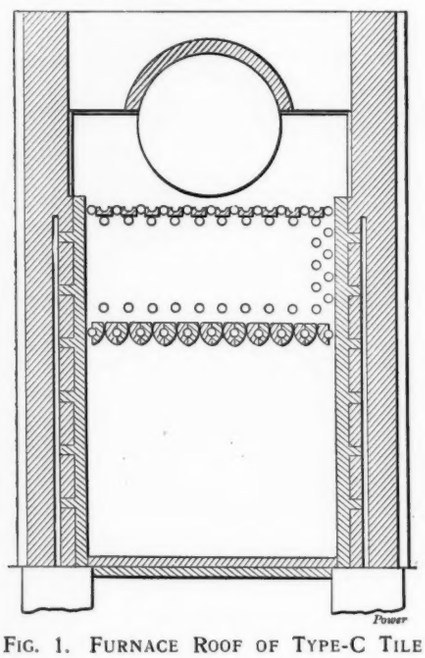


FIG. 1. FURNACE ROOF OF TYPE-C TILE

The form of tile roof used during the first series is shown in Fig. 1 and is designated as type *C*. The tiles completely incase the lowest row of tubes. The form of the tiles used during the second series is shown in Fig. 2. The roof constructed of these tiles is known as type *T*. With this construction the lower halves of the tubes of the bottom row are left exposed to the action of the flames and hot gases of the fire. In Fig. 3 the general arrangement of the boiler and furnace is shown. This arrangement was common to both sets of tests.

The boiler used was a Heine water-tube rated at 210 horsepower. It contained 2027 square feet of water-heating surface. A Green chain grate was used which had an area of 38.25 square feet. Induced draft was used to burn the fuel which was 1¼-inch Illinois screenings and which showed an average heat value of 11,856 B.t.u. per pound of dry coal.

The tests were conducted in accordance with the code recommended by the American Society of Mechanical Engineers. The alternate method of starting and stopping the tests was used.

Conditions were kept as uniform as possible throughout all of the tests. The minimum capacity developed for any one test was 102 per cent. of rated capacity and the maximum was 106 per cent.

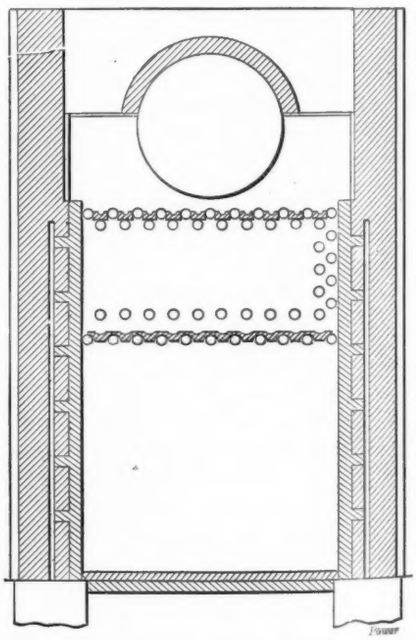


FIG. 2. FURNACE ROOF OF TYPE-T TILE

For the tests with the *C* tile roof, the boiler efficiencies varied from 64.4 per cent. to 66.3 per cent. with an average of 65.6 per cent. For the *T* tile-roof tests the efficiencies varied from 67.5 to 69.4

*Abstract of *Bulletin* No. 34, issued by the engineering experiment station of the University of Illinois.

per cent. with an average of 68.6 per cent. This shows a gain of 3 per cent. in the boiler efficiency in favor of the *T* tile roof. The water evaporated per

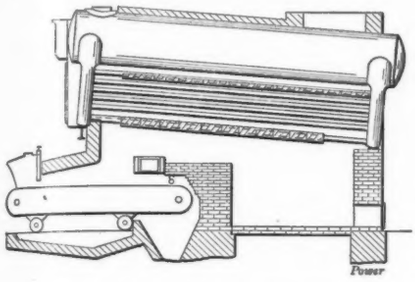


FIG. 3. ARRANGEMENT OF BOILER AND FURNACE

pound of combustible was 5 per cent. more when using the *T* tile than when using the *C* tile. The temperatures in the furnace and combustion chamber were from 200 to 400 degrees Fahrenheit less when using *T* tile than when using *C* tile. This condition should make radiation losses less when the roof is made of *T* tile. Maintenance of furnace, boiler and setting should be easier and less expensive with the *T* tile due to the lower temperatures. Lower flue-gas temperatures are obtained when using *T* tile and are particularly of advantage when using induced-draft apparatus. The tests were not of sufficient length nor at sufficiently high capacities to furnish data relative to the total life of such furnace roofs or to their relative effect upon boiler maintenance in many particulars. It is not uncommonly believed that with uncovered tubes, as with the *T* tile roof, at high capacities, there is much greater danger of injuring the tubes than with tubes covered, as with the *C* tile roof, and, consequently, greater difficulty in regard to boiler maintenance. Uniform and satisfactory fire conditions were more easily maintained during the tests with the *T* tile roof than with the *C* tile roof. It is possible that this condition may have been due entirely to factors other than the difference in roofs. No smoke was made with the *C* tile roof and only smoke of a comparatively unobjectionable color was emitted when using the *T* tile roof. These results were observed at full rated capacity.

In the table a summary is presented of the equivalent evaporation and the efficiency values obtained for all tests.

EVAPORATIVE PERFORMANCE AND EFFICIENCY COMPARISON BETWEEN *C* AND *T* TILE-ROOF TESTS.

Test No.	Equivalent Evaporation from and at 212° F., Pounds.				Efficiency, Per Cent.			
	Per Pound of Combustible.		Per Pound of Dry Coal.		Boiler and Furnace.		Boiler, Furnace and Grate.	
	C	*T*	*C*	*T*	*C*	*T*	*C*	*T*
1	9.88	10.23	7.48	8.07	66.3	68.6	60.5	65.4
2	9.57	10.34	7.56	8.37	64.4	69.4	61.5	67.5
3	9.78	10.12	7.82	8.37	65.9	67.5	62.0	66.1
4	9.80	10.26	7.63	8.31	65.8	68.8	61.9	67.3
Average	9.76	10.24	7.62	8.28	65.6	68.6	61.5	66.6

Steam Engine in No Danger from Gas Engine

That steam engineers need not worry about losing their jobs or turning to gas engineers in the near future was a statement made by Louis M. Ellison before National Association of Stationary Engineers, association No. 1, of Chicago, on April 6. This statement was backed up by figures purporting to show the over-all efficiency of different classes of steam equipment compared to the gas engine and producer.

Starting with the proposition that 2545 B.t.u. constituted the heat equivalent of a horsepower, it was shown that a perfect steam engine would use 2.64 pounds of steam per horsepower-hour. The high-speed engine with 90 pounds boiler pressure and using about 40 pounds of steam per horsepower-hour, it was shown, would have an efficiency of 6.6 per cent. and with a boiler efficiency of 45 per cent. the plant would have an over-all efficiency of 3 per cent. Similarly, with an engine using 35 pounds of steam per horsepower-hour and a boiler efficiency of 50 per cent., the combined efficiency of the outfit would be 3.8 per cent. With a Corliss noncondensing engine using about 26 pounds of steam there would be an efficiency of 10.2 per cent. in the engine and a combined boiler and engine efficiency of 5.1 per cent. As the equipment increased in quality the efficiency could be brought up to 7.3 per cent. for a single-cylinder Corliss condensing engine, 13.2 per cent. for a cross-compound condensing Corliss engine and, using a turbine, with 185 pounds steam pressure and boiler efficiency of 65 per cent., the combined efficiency would reach 15.6 per cent.

Taking up the gas-engine end of the discussion he said that the latter was not comparable to a patent medicine with universal application for all ills, but that its limitations were strictly definable and its over-all efficiency did not equal that which could ultimately be realized by the ideal steam plant. Taking 2545 B.t.u. as a theoretical horsepower and allowing 11,000 B.t.u. per horsepower-hour in a gas engine, the efficiency would be 23.1 per cent. Using gas, therefore, the engine under these conditions would show a slightly higher efficiency than the ideal steam installation, but this was without considering the cost of gas. However, when the producer came to be considered with a commercial efficiency of 65 per cent., it brought the combined efficiency of the producer and gas engine down to 15 per cent. Even allowing 10,000 B.t.u. per horsepower in a gas engine the combined efficiency figured only 16.6 per cent.

With city gas of an average heat value of 625 B.t.u. per cubic foot and 11,000 B.t.u. per horsepower, using the gas engine would give a gas consumption of 17.6 cubic feet per hour as a fair average, which at 85 cents per thousand would result in a cost of 1.5 cents per horsepower-hour.

Taking the cost of steam power on a basis of 1000 pounds of steam at 20 cents, and an engine using 35 pounds of steam per horsepower-hour, the fuel cost would only be 0.7 cent, and for a Corliss engine with a slightly better general equipment, where it would cost 17 cents to evaporate a thousand pounds of water and the engine took 17 pounds of steam per horsepower-hour, the fuel cost would be 0.44 cent. Similarly with a compound-condensing engine with steam costing 15 cents per thousand pounds, and the engine consuming 15 pounds per horsepower-hour, the fuel cost would be 0.28 cent. All of these figures for steam cost were taken, Mr. Ellison explained, as intentionally high. He believed that the cost to evaporate 1000 pounds of steam in the loop district of Chicago did not exceed 12 cents, and on this basis with an economical engine, the fuel cost per horsepower would only be 0.18 cent as compared with 1.5 cents for a producer-gas engine.

In concluding, therefore, he said that it was needless for the steam engineer to worry about the encroachments of the gas engine, as while the latter had its place in the engineering field, yet progress in the steam plant would be sufficient to keep it ahead from the standpoint of efficiency, regardless of its other well known advantages, such as reliability, its large overload capacity and close regulation.

ELECTRICAL DEPARTMENT

ESPECIALLY CONDUCTED *to* BE *of* INTEREST *and* SERVICE *to the* MEN *in* CHARGE *of the* ELECTRICAL EQUIPMENT

A 2000 Horsepower Direct Current Motor

By J. B. Van Brussel

An interesting direct-current motor was installed some months ago at the Peiner Rolling Mills, Peine, Germany, for driving a Liegener blowing engine. Direct current was preferred owing to the large amount of power required and the necessity of providing for speed regulation to regulate the blast in accordance with the requirements of the converter served. The machine is rated at 2000 horsepower when running at 60 revolutions per minute and supplied with current at 500 volts. It is capable of giving an output of 1500 horsepower when running at 40 revolutions per minute and at least 600 horsepower when making 22 revolutions per minute. It is one of the largest direct-current motors yet constructed. The magnet yoke has an over-all diameter of 20 feet 8 inches and the armature and commutator are 15 feet 1 inch and 11 feet 2 inches in diameter, respectively. There are twenty main field-magnet poles and sets of brushes, and commutating poles are provided between the main poles. The brush gear is supported from a special pedestal placed between the machine and the main bearing pedestal, as shown in Fig. 1, instead of from the magnet frame, as is more usual with large direct-current machines. This construction entirely prevents any oil from finding its way to the brush gear and prevents vibration of latter by the motion of the armature.

The starting resistance, which is divided into nine steps, is built up of grids cut from sheet iron and mounted upon porcelain insulators. The contact plates and brushes of the starter are in duplicate, the latter bearing on the two faces of a set of double-surfaced bars and contacts, as may be gathered from reference to the view of the starter in Fig. 2. Since the resistance may be employed to regulate the speed of the motor as well as to start it, all contacts have been made sufficiently massive to carry the full working current continuously. Crossings are entirely avoided in the arrangement of the connections between the contact plates and the resistances, and all parts are open for easy inspection.

The number of actual starting contacts being comparatively small, in order to prevent an excessive increase of current when passing from one contact to another, an ingenious addition has been made to the usual arrangement in the shape of a liquid rheostat, which is located beneath the contact frame. An auxiliary brush is mounted in front of the main traveling brush, and bears against the uppermost of the two bars, which in turn is connected to one of the supply mains through the liquid rheostat. The plates of the latter are operated by a lever attached to a crank mounted on the end of the screw spindle. Upon winding the brushes from the off posi-

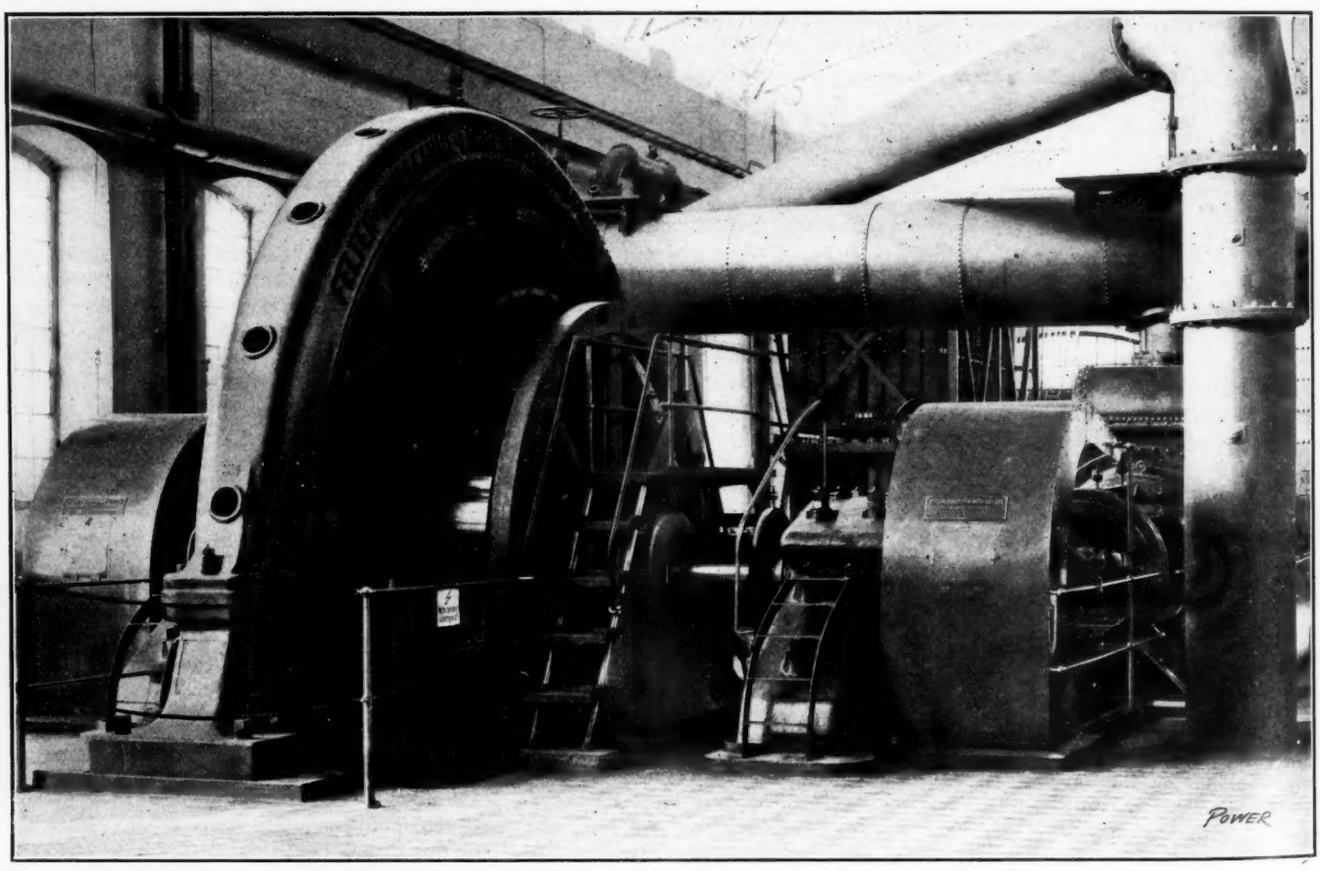


Fig. 1. A 2000-horsepower Direct-current Motor Driving a Compressor

tion of controller, the armature circuit is first established through the liquid rheostat in series with all the main resistance grids. A further motion of the operating handwheel gradually immerses the plates of the liquid rheostat, and thus reduces its value, until, by the time contact is established between the main brush and the first contact plate, the plates of the liquid resistance are entirely immersed. As the main brush moves on to the contact plate, the crank raises the plates out of the liquid in readiness to close the circuit through the second contact. The same cycle of operations takes place at the passing of the brush between each adjacent pair of contacts, the plates of the liquid rheostat being in each case completely immersed before the main brush leaves the preceding contact. The liquid resistance serves the further purpose of preventing sparking at the contacts when reducing speed.

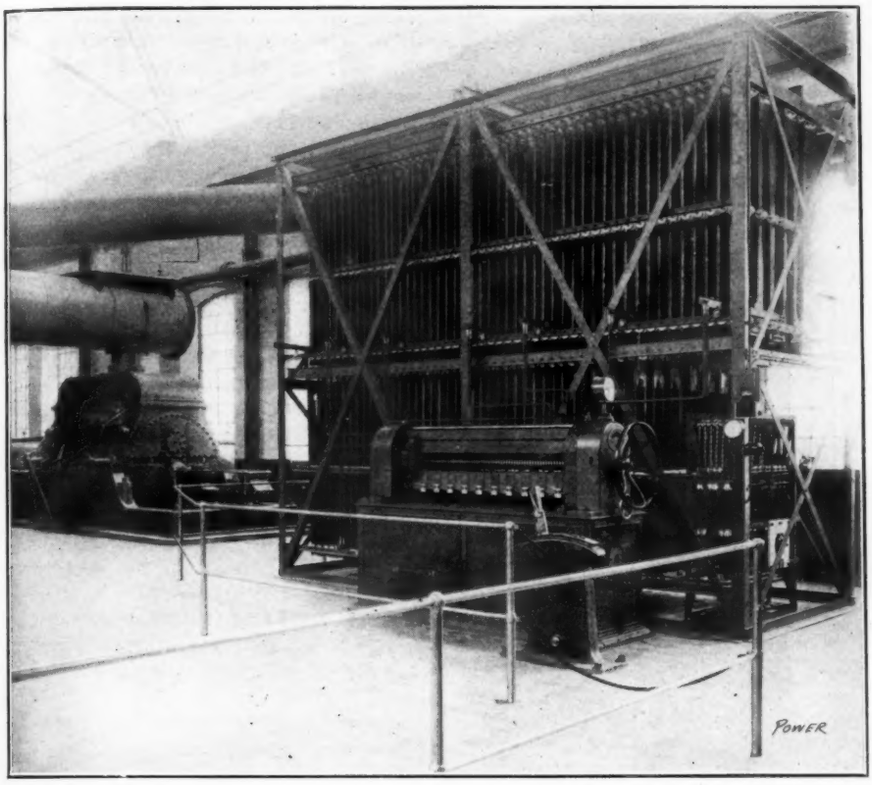


FIG. 2. CONTROL GEAR FOR COMPRESSOR MOTOR

Above the operating handwheel, and built into the supporting pedestal of the starter mechanism a hot-wire ammeter reading to 5000 amperes is provided, and on top of the pedestal is mounted a hot-wire voltmeter. The small handwheel situated below the large operating wheel actuates the rheostat shown on the extreme right in Fig. 2. Its motion is transmitted to the rheostat spindle through two chains. This rheostat is in the field circuit of the motor. In the lower part of the frame, adjacent to the liquid rheostat, but separated from it by a sheet-iron partition, is mounted a single-pole automatic circuit breaker which is closed by the latch-handled lever projecting out of the quadrant casing. In order to prevent it from being closed when the sliding contacts of the starter are not in the "off" position, the circuit breaker is interlocked with a worm gear driven from the screw spindle in such a manner that it cannot be closed until the operating wheel has been wound back to its initial position.

The worm gear also operates a position indicator, showing which contact the main brush is on at any time, and ringing a bell when the brush reaches its final position on each contact, in which position the plates of the liquid rheostat are raised out of the liquid. Thus the operator is warned against leaving the regulator in any intermediate position, in which the whole or the greater part of the current is flowing through the liquid resistance. A pressure gage connected to the compressor delivery pipe is mounted on the smaller resistance framework, to the right of the operator, and a signal bell, affording communication from the converter, is also provided. In addition to this, a glow-lamp telegraph system is now being installed which will enable a complete range of signals to be sent in either direction between the converter and blowing-motor attendant.

Regulation of speed between 22 and 40 revolutions per minute is accomplished by means of the series resistance of the controller, while the motor speed may be increased from 40 to 80 revolutions per minute by field control. In ordinary working a speed less than 40 revolutions per minute is not required, and the waste of power occasioned by the employment of resistance in series with the armature is therefore seldom necessary.

The average duration of a blast is 13 minutes, the pressure commencing at about 20 pounds per square inch, which corresponds to a motor speed of 43 revolutions per minute, and gradually increasing to 32 pounds per square inch, the motor then making about 70 revolutions per minute. The pause between blasts varies between 18 and 24 minutes, and it has been found advantageous not to shut down the motor while recharging the converter, but to let it run light on full field until again required. In this way the compressor is always ready for work, and no time is lost in starting up the motor each time a charge is to be blown. A further advantage is that one man can attend to the whole blowing plant. As the cost of energy to the company is estimated to be only about ½ cent per kilowatt-hour, the extra expenditure caused by running the motor light between blasts is negligible. According to calculations based upon the trial tests, it should amount approximately to 33 cents for each pause, while the average cost of energy per blast should be about $2.06.

In conclusion it may be remarked that the motor has been artificially loaded up to 2630 horsepower at a speed of 70 revolutions per minute without sparking, and that the managers of the Peiner company have expressed themselves as being thoroughly satisfied with its performance. It has been found possible to reduce the average time taken to blow a charge, owing to the fact that the motor has a great reserve of power.

In the presentation of a paper on the Ionization of Gases and Chemical Change, before the Royal Institution, Dr. H. B. Baker, of Oxford, made the following interesting remarks:

Thirty years ago Prof. H. B. Dixon had discovered that the ordinarily explosive mixture of carbon monoxide and oxygen could not be ignited by the electric spark when both the gases were dried as completely as possible. After ten years of experimenting, Doctor Baker said that he had succeeded in showing that pure hydrogen and oxygen would not combine in the absence of moisture. This was shown. Two glass tubes containing these gases, and the one a trace of moisture, were heated by a Bunsen burner; an explosion took place only in the wet tube. The trace of moisture required was exceedingly small, one milligram in 300,000 liters. That meant about as much water as would be produced by evaporating a drop of the size of a pin in the lecture theater.

Motors for Driving Machine Tools*

By Charles Fair

One of the most important features in the selection of motors and one that is persistently overlooked, is the strict adherence to the use of standard motors,

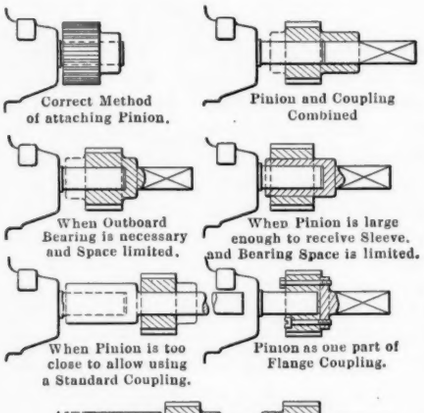

Correct Method of attaching Pinion.
Pinion and Coupling Combined
When Outboard Bearing is necessary and Space limited.
When Pinion is large enough to receive Sleeve, and Bearing Space is limited.
When Pinion is too close to allow using a Standard Coupling.
Pinion as one part of Flange Coupling.
Standard Sleeve Coupling.
Power

Fig. 1. Arrangements to Adapt Standard Shafts

and by standard motors is meant standard armature shafts as well. The importance of using standard armature shafts will be readily recognized by the factory management when it is pointed out that by such an arrangement spare armatures are reduced to a minimum, and that in an emergency it is possible, where these are not carried, to replace an armature, or even a whole motor, from an idle tool or from a tool of relatively less importance at the time. Also, of course, stock motors can be supplied promptly by the manufacturer if special shaft extensions are not called for. That special features in a motor are sometimes desirable is not to be denied; it may so happen that the advantages from some special feature in the motor may more than offset the disadvantages above referred to, but in cases where these features are thought necessary they should be carefully considered before final decision.

The sketches in Fig. 1 show a number of arrangements used in order to maintain standard sizes of motor shafts. In addition to these, many forms of flange and split couplings are used. The method chosen for connecting standard shafts will depend upon the conditions surrounding the drive under consideration. In the early days of motor drive many special features were thought necessary in the motor to adapt it to the tool; special frames, shafts and speeds were required by the tool builder, and little thought was given to the interchangeability of parts. It is therefore easy to recognize in these early equipments responsibility for the existing idea that special features in the motor are still necessary for tool equipments. Many of these features are now recognized as unnecessary, and today the tool builder in many instances builds his tools ready for attaching standard motors.

*Abstract of a paper read April 12, before the American Society of Mechanical Engineers.

The Control

Equally important with the choice of motors is that of control. In selecting the means of control it is necessary to consider the nature of the work, accessibility to the operator, the method of attaching the controller to the tool and in some cases its relative position to other tools; for instance, an open-type starting rheostat should not be exposed to danger of short-circuit from flying chips. In the majority of cases, shunt-wound motors of ¾ horsepower and less may be started by a switch; exceptions to this would be motors on tools that

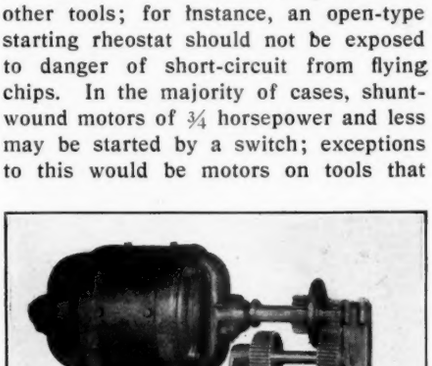


Fig. 2. A Modernized Lathe Headstock

must be gotten under way slowly, and grinders driven by direct-current motors, for reasons of safety. With adjustable-speed motors, care should be taken to throw the switch on full field. Most series motors up to 8 horsepower or even larger can be started by a simple switch; exceptions to this would be cranes and tools requiring a certain amount of armature-speed regulation. Larger motors, for tools where starting is infrequent or not severe, and for line-shafts and for group drives, would be satisfactorily operated with a dial-type controller, which is cheaper than the drum controller; the controller, however, must be placed in a protected position.

When making the installation, accessibility to the controller in case of accident should be kept in mind, even though of little importance so far as starting up is concerned. The starting apparatus should be placed where the motor or some of the moving parts can be seen by the operator. On individual motor-driven tools, where the motor is started and stopped many times a day, or where the starting conditions are severe, or where tools are "inched" along, drum controllers with extra-heavy starting resistances should be used. For adjustable-speed motors, using drum controllers, the field control should be through fingers making contact on segments of the controller drum and not by sliding contacts on a dial, as with the latter trouble will develop sooner or later. Motors above 40 or 50 horsepower, under these severe conditions, are best operated by a master-controller which operates contactors for cutting out steps of the starting resistance, and if adjustable speed, the field control should be effected by fingers making contact on segments of the drum. This class of starting apparatus will stand much abuse and by the addition of a simple current-limit relay becomes practically a fool-proof protection for the motor.

Upon the convenient arrangement of the control depends, to a considerable degree, the output of the tool, and the importance of the arrangement from the standpoint of the operator cannot be ignored, since the output of a tool will be materially increased when an operator can start and stop the tool and obtain at all times maximum cutting speeds by simply turning a handle. The controller must be placed in a safe position and should be accessible for repairs, which very often means that some arrangement is necessary to bring the operating handle within easy access of the operator. A familiar example of convenient control is the arrangement so commonly seen on lathes, whereby the operating handle travels with the tool carriage and gives the operator at all times prompt control of his tool. Strange as it may

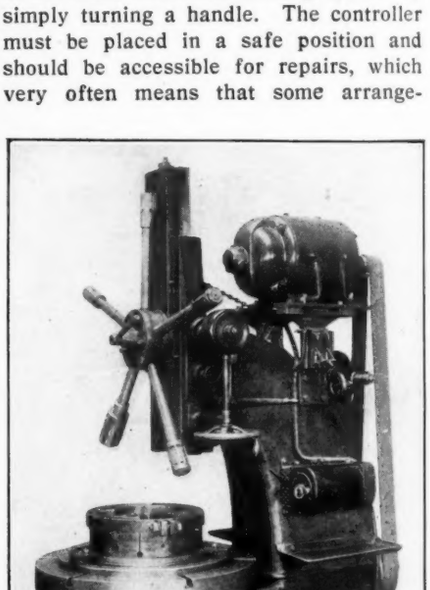


Fig. 3. Motor Applied to an Old Chucking Machine

seem, this most important feature, the convenience of control, which bears directly on production, is ignored in the majority of the tools; where the control is of the greatest importance.

Power Required

The horsepower required for driving tools calls for the exercise of considerable judgment, especially in the case of alternating-current motors where the factor enters into consideration. Exhaustive tests have been made to determine the amount of power required to drive tools, but many of these tests, unfortunately, lacked the essential features that would make them valuable. Conclusions drawn from incomplete data are apt to be misleading; as in the case of tests made with motors which are considerably underloaded or overloaded, and where efficiencies are not taken into consideration; or where the material used and the duration of test are not stated; or where there has been failure to state whether the test was a practical one or merely a breakdown test. The conclusions drawn from breakdown tests are often deceptive and should not be used for determining power to drive tools; also it does not follow that a tool which stands up longer than another under breakdown conditions, will do the same under practical conditions. The majority of the formulas now in existence for computing horsepower required for tools is generally misleading and useless, and no general formula that would be of practical value has been developed, as the power required varies with the metal worked, the cutting speed and many other conditions.

The construction of the tool is seldom taken into consideration when estimating horsepower, yet some of the worm-driven tools are notoriously inefficient. Other tools are so constructed that the greatest part of the power delivered to the tool is consumed in friction losses; again, the tool may be constructed upon approved lines but may not be stiff enough to stand the strains to which it is subjected, thereby causing considerable loss of power, all of which, as well as the difference in power due simply to the shape of a cutting tool, has been repeatedly proved by tests. In one instance, it required 72 per cent. more power to drive a plain spiral milling cutter than the same cutter nicked.

Remodeled Tools

Figs. 2 and 3 show two interesting methods of attaching motors to old tools. Fig. 2 shows the headstock of what was originally a belted 24-inch lathe changed to a motor drive. This equipment makes a very durable and satisfactory drive; the motor is a standard 5-horsepower, 500- to 1500-revolutions per minute adjustable-speed machine. The shaft carrying the sliding pinions and handwheel is made large enough to receive the motor shaft, thus avoiding the use of a special armature shaft. Room was left between the sliding pinion and gears sufficient that the pinions might be turned freely when sliding from one gear to the other.

Fig. 3 shows a 36-inch chucking machine driven by a 5-horsepower 500- to 1500-revolutions per minute adjustable-speed motor, and shows a very simple method of attaching the motor; in fact, the brackets for supporting the motor were originally made for an entirely different machine.

CORRESPONDENCE

Another Case of Mere Common Sense

Reading the article on Gas Engine Cylinder Lubrication, by Frank E. Booth, in the February 22 issue reminds me of a little incident in connection with a gasolene engine I was called on to start up. The engine was a new one and the owner, not understanding much about it, had employed a man who was well known in the locality as a mechanic to set it up and start it. But it persistently refused to start, and after the local genius had exhausted his profane vocabulary they telephoned me to come over and get stuck too.

I accordingly went over and looked things over as closely as I could, with the local engineer to point out what he had done and suggest what ought to be done. Upon turning the engine over a time or two, I noticed that the igniter did not trip, and to get the local man out of the way for a short time I took off the trip finger and told him to go and file it smooth where it came in contact with the igniter trigger. Then I examined the engine more closely and soon found that the cam bar that operated the igniter did not work as it should. It was forced by a cam against the igniter to trip it and pulled back by a coil spring. A lot of paint and cinders had got in between this bar and the engine frame, where the intervening space was small, and jammed it so that the spring was not strong enough to draw the bar back against the cam. Of course the igniter could not trip, and all the cranking and cussing in the world would not start the engine. I cleaned the obstruction out and oiled up, and the man came back about that time, swearing about that piece of steel; said he could not file it. Of course it was hardened, and I afterward told him I did not think he could hurt it any. I put on the finger, adjusted the ignition timing, and the engine started up at the first trial. Really, what I did was just about as ridiculous as the man Mr. Booth speaks of, going 50 miles to squirt a little oil on the igniter stem.

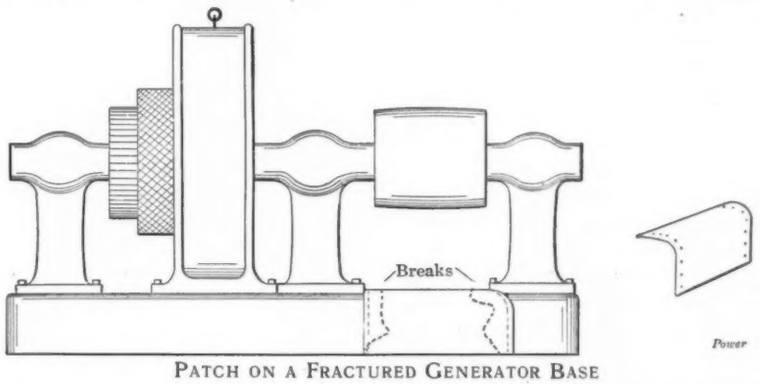
It is just such talent, however, operating gas and gasolene engines that gives them a bad name.

W. L. James.

Fruitland, Wash.

A Generator Base Repair

In a power plant in Charleston, S. C., a flywheel accident occurred some years ago, which not only partly wrecked the engine but also knocked out a considerable portion of one side of the base frame of a large direct-current generator. This was a three-bearing belt-driven machine running at 400 revolutions per minute. Many engineers would have decided that the only thing to do was to purchase a new base, but Chief Engineer J. O. Moisson felt sure that the broken base could be repaired and made to do service for several years more. His method of repairing it was as follows:



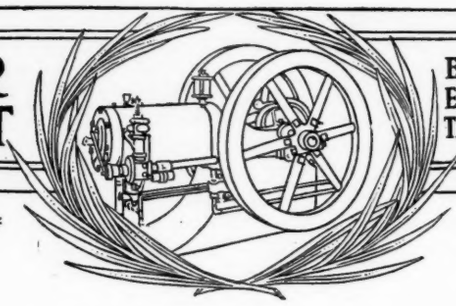
Patch on a Fractured Generator Base

A piece of sheet iron ⅜ inch thick was bent to conform to the rounded edge of the base and also to the curved end of the same, the latter formation being made feasible by cutting a slot in the horizontal flange of the iron plate so it could be bent, without buckling, to the corner curve of the base. When this had been accomplished, holes were drilled in the plate as indicated in the sketch and corresponding holes were drilled in the solid part of the base frame; then the plate was riveted to the frame, completing the job. That it was successful is shown by the fact that the generator has been in service continuously ever since the repair was made and is now being displaced only to make room for a unit of larger output.

R. O. Warren.

Birmingham, Ala.

GAS POWER DEPARTMENT



EVERY THING WORTH WHILE *in the* GAS ENGINE *and* PRODUCER INDUSTRY WILL BE TREATED HERE *for the* USE *of* PRACTICAL MEN

Possible Uses of Waste Gas Power*

By I. V. Robinson

The surplus power from blast furnaces capable of producing 100 tons of pig iron per day has been estimated by Leon Greiner, Liége, as follows: Heating the blast, 45 per cent.; blowing engines, lifts, etc., 15 to 20 per cent.; available balance, 35 to 40 per cent.; equivalent surplus power, brake horsepower per 100 tons per 24 hours, 3020. This estimate is based on a heat consumption of 9370 B.t.u. per brake horsepower-hour, and this figure is very closely confirmed by a test carried out some time ago with an 1100-horsepower (brake) engine built by Richardsons, Westgarth & Co., Ltd.

Various data have been published regarding the running costs of gas engines. Some of the engines were supplying power to machine shops working about 54 hours per week, and the load factor was only about 20 to 25 per cent. Other engines were supplying power to combined iron and steel works, etc.; these engines may be running practically full time (8760 hours per year), but they are not always fully loaded; the load factor is only from 50 to 65 per cent. Again, some gas engines were running fully loaded for practically full time, driving blast-furnace blowing cylinders, with a load factor of 95 per cent. In order to compare all these cases, the total costs of repairs, maintenance and stores require to be corrected to a common load factor of 100 per cent.

Mr. Greiner states that his total costs when working under a load factor of 50 per cent. amounted to 0.0465d. per electrical horsepower per hour. He estimates that the cost with a 100 per cent. load factor would be 0.0233d. (0.0467 cent) per hour, of which cleaning and repairs would amount to 35 per cent. This is equivalent to 6s. ($1.46) per electrical horsepower per year. The average cost of repairs per electrical horsepower per year of various installations cited is 3s. 4d. (82 cents). The average cost of oil, waste and stores, etc., in three actual cases is 3s. 3d. (80 cents) per electrical horsepower per year. The cost of labor will probably vary from 4s. to 8s. per electrical horsepower-year in large and small stations, or a mean of 6s. ($1.46).

It would thus apparently be safe to assume that the total works charges on a large gas-engine installation would not exceed 12s. 7d. ($3.10) per electrical horsepower-year. But to allow a margin to cover contingencies and management expenses, the cost will be taken as 15s. ($3.65). Providing for 5 per cent. interest and 7½ per cent. depreciation, the total cost per electrical horsepower per year will be £2 5s. (practically $11).

Blast-furnace owners have available a large amount of power for which they have not, up to the present, found any useful purpose, and in their immediate neighborhood there are large corporations or power companies which have equipped power stations to supply power within their boundaries. There is no reason why blast furnaces should not eventually supply practically all the power that is required in the neighborhood, and the cooperation of the blast-furnace owners and the power-supply departments and companies would be a mutual advantage.

In a gas-engine station using blast-furnace gas, an electrical horsepower can be generated for a complete year at a total cost of about £2 5s. To this has to be added the profit, which will be assumed to be 10 per cent. of the capital cost of the plant, or 24s. per electrical horsepower-year. This item may be regarded as the cash value of the gas used, and is equivalent to 0.044d. (0.09 cent) per kilowatt-hour generated, assuming a 100 per cent. load factor. Allowing for 5 per cent. of the power being used in the power station, the sale price at the power station will be £3 12s. 9d. ($17.75) per electrical horsepower-year.

The power generated at the various works could be collected at a central transmission station, from which overhead transmission lines would convey the power to the boundary of the purchasing corporation's area. If a local power company purchased the power, it would be in a splendid position to attract 100 per cent. load-factor consumers, who would then be induced to start special works in the immediate vicinity of the central collection and transmission station.

Assuming that a special company were formed, the capital required would be about £160,000, the total cost of the transmission lines, transformers, etc., being about £140,000. This allows for generation and transmission at 10,000 volts and step-down transformers at the consumers' boundary. Allowing 5 per cent. interest and 5 per cent. depreciation, the annual capital charges will be £15,000. The transmission lines could be kept in order for about £3000 per year, and an allowance of £1000 per year for rights of way, etc., makes the total transmission costs £19,000 per annum. The aggregate output of the various stations is 62,000 electrical horsepower × 0.95, or 58,900 electrical horsepower. The transmission charges are therefore about 6s. 5d. ($1.57) per electrical horsepower-year, and allowing for 7 per cent. loss in transmission, etc., the total sale price at the corporation's boundary would be about £4 5s. ($20.70) per electrical horsepower-year.

The Glasgow Corporation electricity department in the year ending May, 1909, had a maximum demand of 21,585 kilowatts, or about 29,000 horsepower, and the total works charges amounted to £69,000. This is equivalent to a works cost of £2 7s. 6d. ($11.57) per horsepower of maximum demand. In the tramways department the maximum demand was 12,150 horsepower, and the total works charges were £37,850. In this case the works costs were £3 2s. 4d. ($15.18) per horsepower of maximum demand. The above figures are based upon load factors of 18.35 per cent. and 37.5 per cent., whereas the estimate for the blast-furnace power station is based upon a load factor of 100 per cent. Under existing conditions it would probably pay the corporation to take, say, one-half of its maximum demand from the blast-furnace gas-power stations and generate one-half from its own coal-fired stations, the exact proportion depending entirely upon the average daily load curve.

A scheme has been started on the northeast coast of England, where a subsidiary and nonstatutory company named the Waste Heat Power Company has purchased the gas from the furnace owners, equipped power stations to use this gas, and sold the power to the various power companies which are working together in Northumberland, Durham and Yorkshire.

With reference to the reliability of the gas engine, it may be stated that two 1100-horsepower gas engines which were supplied to the Coltness Iron Company by Richardsons, Westgarth & Co., Ltd., during the past year ran 15,043 hours of the total possible 15,698 hours.

In the author's opinion it is quite possible for many processes which, up to the present, have only been worked by

*Abstract of a paper read before the West of Scotland Iron and Steel Institute, February, 1910.

water power, to be adopted in such districts where cheap power can be obtained by the proper utilization of the waste gases. Many chemicals are being manufactured in electric furnaces supplied with power from producer-gas power stations and from coal-fired steam-turbine stations. From neither type of power station can power be obtained at such a low rate as from the waste-gas station. Where iron and steel works are adjoining, considerable fuel economy could be obtained by arranging for all mills to be driven by motors. Electric steel furnaces could be adopted with profit.

The station-operating costs per kilowatt-hour of the Glasgow Corporation electricity department for the year ended May 31, 1909, were as below:

	Pence.	Cents.
Fuel	0.25	0.508
Oil	0.02	0.041
Repairs	0.05	0.101
Wages	0.10	0.203
Total	0.42	0.853

The total output was 32,736,058 kilowatt-hours, and the average load factor of the station was 18.35 per cent. Correcting the various items for the difference between load factors of 100 per cent. and 18.35 per cent., it has been assumed that the fuel used per kilowatt-hour will be reduced in the ratio of 1.298 to 1; the cost of repairs and of oil will probably be three times as much as for the 18.35 per cent. load factor, and the total cost of wages per annum will be increased by 20 per cent. The total cost per kilowatt-hour sold will then be 0.2530d. (0.514 cent), equivalent to a total cost of £6 17s. 6d. per electrical horsepower per year.

At the Glasgow Corporation tramways-department power station the total works cost is 0.35d. (0.17 cent) per kilowatt-hour, the output is 25,944,010 kilowatt-hours, and the load factor 37.5 per cent. Dealing with the various items, as before, the wages are increased 10 per cent., the oil 47 per cent., the repairs 47 per cent., and the fuel has been decreased in the ratio of 1.184 to 1. With these corrections, the total cost works out at 0.2257d. (0.458 cent) per kilowatt-hour, or £6 4s. ($30.19) per electrical horsepower-year.

By taking the lowest recorded cost for each item in any British power station, and correcting the amount for a 100 per cent. load factor, the following figures are obtained:

Fuel, 0.1346d.; oil, 0.0055d.; wages, 0.0102d.; repairs, 0.0275d.; total, 0.1778d. (0.361 cent) per kilowatt-hour. This amounts to £4 16s. 9d. ($23.57) per electrical horsepower per year.

This figure is, then, the lowest cost at which power could be generated in the average modern power station, while with blast-furnace gas-power stations the cost per electrical horsepower-year would be £2 5s. ($11), which is less than half the average power-station figure.

[While the foregoing argument and figures are based on British conditions and practice, the general principle is, of course, equally well applicable to American conditions and practice. The modifications necessary to transpose from British to American conditions are not sufficiently radical to invalidate the argument or nullify all of the advantages obtainable in Great Britain. Greater distances and higher labor costs in this country are the principal important differences.—EDITOR.]

Oil Engine Diagrams as Affected by Fuel Pump Setting

BY J. P. COLTON

The accompanying diagrams were taken from a Hornsby-Akroyd oil engine with a 16-inch cylinder and 20-inch stroke, running at 200 revolutions per minute.

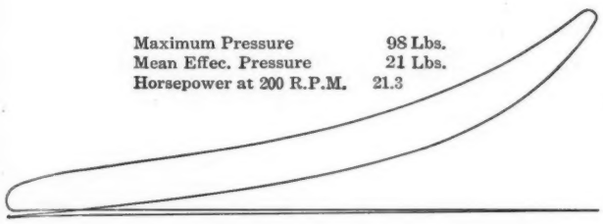


FIG. 1

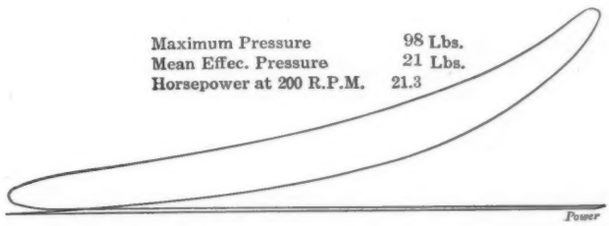


FIG. 2

DIAGRAMS FROM A 16x20 HORNSBY-AKROYD OIL ENGINE

The engine was belted to a triplex pump working against 200 pounds pressure. The fuel was Ohio crude oil.

The diagram in Fig. 1 was taken under normal running conditions. Fig. 2 was taken with the stroke of the fuel pump shortened just enough to prevent the governor from touching the overflow valve—that is, all the oil handled by the pump went into the cylinder. The load was the same as in Fig. 1.

Fig. 3 was taken with the fuel pump set at a longer stroke than when Fig. 1 was taken. It shows too early an ignition of the charge, of course, the ignition occurring at the point indicated by the arrow instead of at the end of the compression stroke.

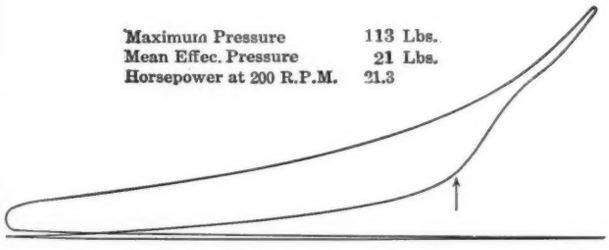


FIG. 3

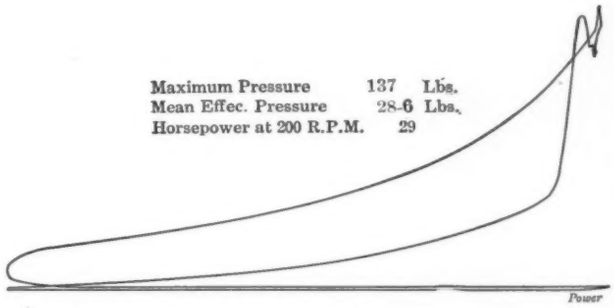


FIG. 4

DIAGRAMS FROM A 16x20 HORNSBY-AKROYD OIL ENGINE

Fig. 4 shows a diagram taken with exactly the same pump setting as the diagram in Fig. 2. This, like Fig. 3, shows too early ignition, and it also shows an increase in indicated horsepower not due to any manual change in load adjustment and an odd loop near the peak of the diagram. The only changes consciously made during the taking of these four diagrams were the adjustments of the fuel-pump stroke described.

I should like to have other readers express their opinions in POWER of the diagrams.

Petroleum and Natural Gas in the Philippines*

By Warren D. Smith

There has been considerable interest aroused within the last year by the tapping of small reservoirs of natural gas in the course of drilling for artesian water. Two of these cases were investigated and it was found that only a small pocket of gas had been penetrated and that the supply was exceedingly small and intermittent.

Petroleum has been found in five places in the archipelago—three in Tayabas province, one near the center of the island of Cebu, on the west coast, not far from Toledo, the other near the southern extremity of that island, close to the pueblo of Algeria. In Tayabas and at the first-named locality in Cebu some prospecting by means of boring has been carried on, but as yet the Algeria field remains practically unknown.

In Tayabas province, on the east coast of the peninsula, south of San Narcisco, Mr. Cook drilled a well 21 meters deep and found some oil. On the Bayhay river, about 8 kilometers from the coast, there is another well 40 meters deep, the yield of which at the beginning was reported to be about 190 liters per day. The well has a five-inch bore and the oil appears to be of a very good grade. It has a paraffin base and its composition is very like that of the Sumatran oils.

In Cebu, near the town of Toledo, about three miles from the coast and just at the edge of the foothills, are two wells, the first to be sunk in the Philippine archipelago. These are sunk in shale strata to the depth, respectively, of 244 and 344 meters. Very fair shows of oil have been reported from these wells in former years, but nothing has been done in this field since the outbreak of hostilities in 1897. The ground surface at these wells is 23 meters above the sea level.

About 2 kilometers from the oil well is an outcrop of coal, which in former years was worked to some extent, but is now abandoned. From a hasty inspection of the country it is my opinion that the strata are less disturbed in this portion of the island than on the eastern side of the Cordillera or to the south, in the vicinity of the Algeria oilfield. It is the intention of the Division of Mines to undertake a more detailed survey of this region at an early date, with a view to the rapid delimitation of the coal and the oil-bearing horizons.

At Algeria the oil is found at an elevation of 350 meters on the Malbog creek, about 3 kilometers in a straight line from the coast. At 441 meters a bed of poor brown lignite is found. The strata here dip eastward, or into the island, being quite different from what was found in the Toledo field. The rock capping on the surrounding hills is a coralline limestone of probable Pliocene age. The oil appears to be identical with that from the other two fields and is found oozing out of the same bluish shale.

With reference to the likelihood of finding oil on the east coast of Cebu, I might add that, although the sedimentary formations are the same, a great area of igneous rock which occurs there would cause serious interruption to the oil-bearing formation. The apparent connection between coal and oil deposits in Cebu and other islands of the group leads me to think that in time oil may be found in paying quantities in many parts of the archipelago.

*From "Mineral Resources of the Philippines," issued by the Bureau of Science, Manila.

LETTERS

The Gas Turbine

I was much interested in Mr. Griepe's article on the gas turbine in the issue of March 8; perhaps you will allow me to make a few remarks on the subject.

As Mr. Griepe states, one of the chief difficulties has been to build rotors capable of withstanding the high temperatures encountered. According to the table which he gives from the data obtained by Dr. Wegner, the lowest actual temperature is about 1800 degrees Fahrenheit. This is for atmospheric pressure and, of course, the temperature is much higher at the explosion pressure. Now it is very easy to build nozzles of refractory material, capable of withstanding the explosion temperature, to expand the gases to atmospheric pressure before they wash the blading. This means the De Laval type of machine, and in my judgment this seems to offer the greatest possibilities simply for the reason that it gives a minimum temperature for the gases striking the rotor. It seems futile to design rotors for temperatures higher than that of the gases when fully expanded, for the difficulties are great enough then. For this reason Stolze's turbine appears to be more practicable, or perhaps less impracticable, than most others. Explosion chamber and nozzles could be maintained safely at a high temperature, which means good thermal efficiency.

Another difficulty is the fact that much higher nozzle velocities would be met with than in steam practice. If not too great, this, of course, could be overcome by using the velocity-stage type, as Stolze proposes. Here also it seems useless to attempt designs of single stages; ideal wheel-rim velocities cannot be approached in steam turbines, so it seems futile to try it here where the gases reach much higher velocities. Cannot someone give us figures on this subject?

A third difficulty lies in constructing an efficient rotary air compressor for the pressures required; this, I believe, has never been accomplished. The inverted turbine type has been developed by the General Electric Company to a fair efficiency for low pressures, but not for such pressures as would be required by the gas turbine. Even if this type of compressor should reach such an efficiency as to make it practical for this work, its use would about double the cost of construction, for it is another turbine in itself, with blading and all fully as expensive as the turbine proper. Why not employ reciprocating compressors? Spiral and worm gearing can now be made with very high efficiencies and the reciprocating compressor has reached an advanced stage of development.

Water jackets and water circulation have always been the most simple and most obvious means of reducing the temperature of the rotor and the casing. I once spent a great deal of time designing a gas turbine with an elaborate system of water jackets which would allow steam under pressure from the jacketing to expand through separate steam nozzles against the rotor, thus cooling it. But the discovery was later made that the French, as usual, had already experimented in this direction and found it impracticable. Water jackets, by carrying away heat, lower the thermal efficiency of any heat engine but in this case they seem indispensable unless some new substance can be found to withstand the temperature to which the casing would be subjected.

Mr. Griepe's turbine design certainly is ingenious; but the thin web of the rotor would be subject to considerable expansion and contraction, which would necessitate a large clearance between the explosion chambers and the ring of buckets, tending to induce leakage.

Does anyone know of experiments made upon a gas turbine using the Diesel principle of injection of fuel?

Chas. H. Roe, U. S. N.

Guantanamo.

A recent issue of *Cassier's* states editorially that the first British steamboat was not Bell's "Comet," which ran on the Clyde in 1811, but the "Accommodation," which commenced running between Quebec and Montreal on the St. Lawrence river on November 5, 1809, or two years after the "Clermont" made her official run from New York to Albany. The first steamers on the Lakes were the "Ontario" and the "Frontenac," which appeared in 1816.

As proof of the great interest that is being taken in exhaust and mixed-pressure turbines, it is interesting to note that over 50,000 kilowatts have been sold to date by the General Electric Company, the average machine capacity being slightly over 1400 kilowatts.

FROM READERS *with* SOMETHING TO SAY

PRACTICAL INFORMATION *from the* MAN *on the* JOB: A LETTER GOOD ENOUGH *to* PRINT *is* GOOD ENOUGH *to* PAY *for*

Compression in High and Low Speed Engines

Fig. 1 shows a diagram from a 16x36-inch Corliss engine, running 102 revolutions per minute, giving a piston speed of 612 feet per minute. The events are well timed, compression not being excessive but at the same time ample for the conditions, as evidenced by the smooth running of the engine. Lead is not too early, and yet is amply early to secure full initial pressure on the piston at the beginning of the stroke.

Fig. 2 is from a high-speed engine, 17x15-inch, running 277 revolutions per minute, and the piston speed is 692 feet per minute. Note the difference in the steam distribution between these diagrams and Fig. 1. The difference in piston speed is about 6½ per cent. while the difference in compression is fully 30 per cent.

Fig. 3 shows diagrams from the same engine as Fig. 2. It will be noticed that cutoff is later in this case, and that lead

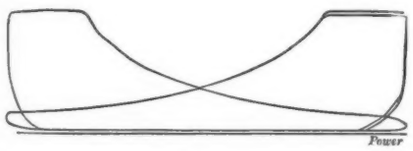


FIG. 1

and compression are later. Under the conditions shown by Fig. 3 the engine operated much more smoothly than under those shown by Fig. 2.

Fig. 4, as shown by the solid lines, is from an engine having fixed compression and lead. The valves are of the piston type, the cutoff valve working inside the main valve controlling admission and exhaust. The main valve is operated by a

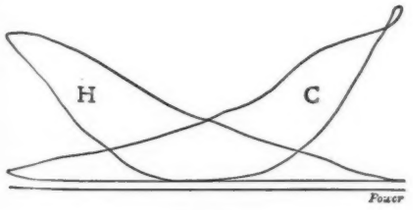


FIG. 2

fixed eccentric and the cutoff valve by an eccentric under the control of the governor. Both main and cutoff valves are kept steam tight by means of packing rings. This engine has a cylinder 18x24 inches, and the speed is 200 revolutions per minute. The piston speed is 800 feet per minute. Now if compression as shown in Figs. 1 and 2 is necessary to secure smooth running at 692 feet piston speed per minute, what would be required at a speed of 800 feet per minute?

The compression would be something near that indicated by the dotted lines. This reduces the area of the diagram at the bottom, and since the area of the diagram, all else being the same, must

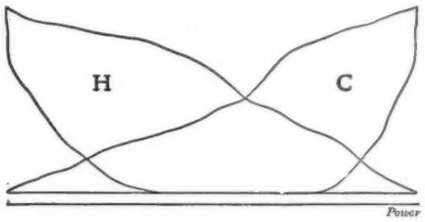


FIG. 3

be equal for a given output, this area must be added elsewhere, and the only way this can be done is to increase the admission as shown by the dotted lines at the top. This, as is shown, causes higher pressure at the point of exhaust opening, and since the measure of the efficiency of an engine is the temperature of the exhaust steam, there is considerable waste of energy that might be

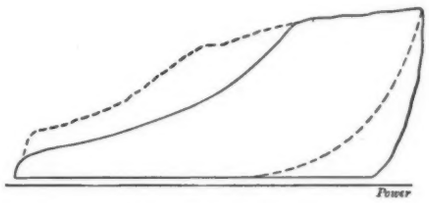


FIG. 4

utilized by taking this brake load due to excessive compression and lead from the engine. The fact that the engine from which the diagrams shown in Fig. 4 were taken runs more smoothly than other high-speed engines having much greater compression and lead, is or ought to be considered pretty good evidence that the steam distribution in this case is more nearly correct.

Fig. 5 is from a 36x54-inch Corliss engine which has been in operation for about 16 years, running 80 revolutions per minute. This gives a piston speed of 720 feet per minute. I believe that such examples clearly indicate that in order to insure smooth running in high-speed engines it is not necessary to use relatively more lead and compression than is required for the so-called slow-speed engine. Take, for example,

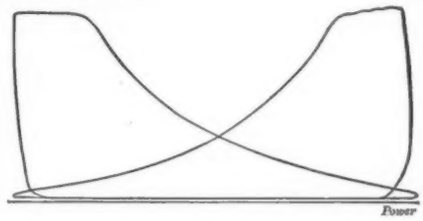


FIG. 5

two engines, one having a stroke of 12 inches, and operate it at a speed of 300 revolutions per minute, and another having 36-inch stroke having a speed of 100 revolutions. In each case the piston speed is the same, and as there is no necessity for the parts to be much heavier relatively in the one than in the other, why should so much more compression and lead be required in one case than in the other?

WILLIAM WESTERFIELD.

Lincoln, Neb.

Opening a Clogged Blowoff Pipe

One evening the engineer phoned to me at the office and said that the blowoff on the boiler was clogged and he could not blow down the boiler as was the custom at that time of day. "Try the back feed," I replied.

"I have and everything else and cannot get it started," the engineer said.

"All right, I will come down and start it for you in five minutes," I laughingly replied. I started for the plant without the least idea as to how I was going to fulfil my promise. On reaching the plant I went behind the boilers which were arranged so that the feed water could be pumped in through the blowoff in case of emergencies. I told the engineer to turn the pump on the back feed again, and I opened the blowoff valve and allowed the water from the pump to flow directly to the sewer instead of into the boiler. When the pump was throwing the water at a good speed to the sewer I closed the valve as quickly as possible, thus suddenly turning the water to the boiler. After repeating this operation a few times the obstruction came loose and the boiler began to blow off.

The theory of the above is that when a rapidly moving column of water is suddenly stopped the inertia of the wa-

ter causes it to strike a hard blow against whatever obstructs its flow. In the above instance the force of the blow was directed against the obstruction in the blowoff pipe and it would have been a very bad obstruction indeed which could have resisted my treatment.

G. E. MILES.

Denver, Colo.

Engineers' Stethoscope

The majority of engineers are, no doubt, familiar with the physicians' stethoscope, the little instrument which is placed over the heart or lungs of a patient for the purpose of discerning any irregularities that may be present more clearly than would be possible with the ear alone. The instrument is primarily an intensifier.

A useful instrument, which for lack of a better name we shall call a stethoscope, is being used to advantage by many practical engineers.

By its use the engineer can more readily detect existing errors than is possible by means of the ear. Its use has been found valuable in detecting loose follower bolts or nuts, broken snap rings, leaking pistons, etc. In the examination of flywheels for fractures or loose bolts it is also found useful. The mere ring of a hammer blow is oftentimes deceiving when the unaided ear is depended upon to catch the sound.

Engineers sometimes put one end of a pencil or rule between their teeth and

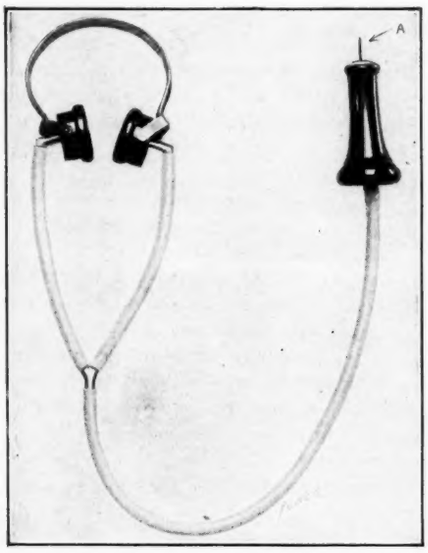


FIG. 1. THE ENGINEER'S STETHOSCOPE

hold the other end against a water or steam line to determine if the flow is normal. The same principle is made use of in the stethoscope.

The material for its construction can be obtained for practically nothing at a telephone exchange. New material is not necessary. Old, slightly-cracked receiver shells will answer the purpose. Fig. 1 shows the instrument assembled ready for use. The rod *A* is placed against the cylinder, water pipe or flywheel rim,

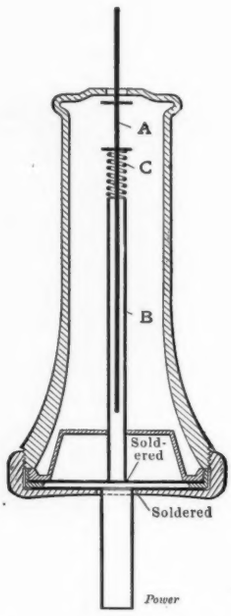


FIG. 2. THE TRANSMITTER

while the small receivers are placed to the ears. One receiver will do if two are not obtainable. The connections are made of ¼- or ⅜-inch rubber tubing. Fig. 2 shows the construction of the contact receiver.

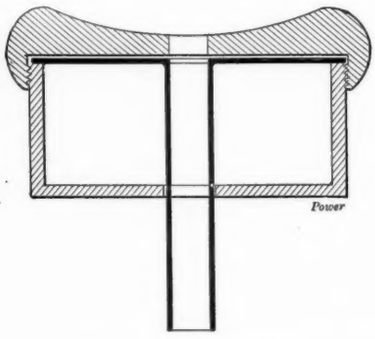


FIG. 3. THE RECEIVER

The small spring *C* is inserted between the rod *A* and tube *B* to prevent pressing the rod *A* so tightly against the object being tested that slight vibrations cannot be detected. The faint sounds caused by the existing error is transmitted through the rod and tube against the regular telephone-receiver diaphragm. The sounds, here intensified, are conducted through the tube connections to the diaphragm in the small receiver, Fig. 3.

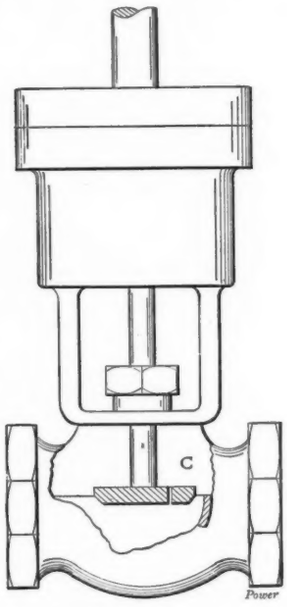
Any engineer can make this instrument during spare moments and its regular use may save serious accidents.

N. L. DANEY.

Elyria, Ohio.

Feed Water Regulator

It is not an uncommon occurrence for feed-water regulators to give considerable trouble. This is due partly to the way in which the regulator is built and in a measure to the way the regulator and pump are proportioned for the duty. For instance, if our regulator closes the pump, the latter will come to a standstill and will remain cut out until considerable variation in the water line has occurred, at which point the regulator will open the steam valve to the pump suddenly, starting the pump at a high rate of speed, which has a tendency to wreck the pump or cause undue wear.



SECTION SHOWING HOLE IN DISK

This can be overcome and a much better system of regulation obtained with the same style of regulator by simply drilling a small hole through the disk of the steam valve so that the pump will be cut down when the water line is reached but not stopped entirely. It will then move along slowly, and when the water line is low, the valve will open and allow the pump to work to its capacity. The small hole through the valve disk is shown at *C* in the accompanying cut.

C. R. MCGAHEY.

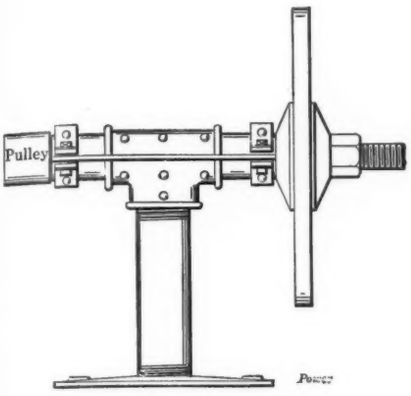
Sheffield, Ala.

Homemade Head for Emery Wheel

A friend of the writer's having use for an emery-wheel head but not wishing to invest eight or ten dollars for it, constructed one as shown in the figure. A mandrel was found stowed away on a shelf and the remaining parts were made from rather crude materials.

The base is one-half of a muffler to a gasolene engine, into which is screwed a 2-inch pipe nipple about 8½ inches long. After being screwed into the base the pipe was swelled with a few blows

of a hammer from underneath to keep it from working loose. On the other end of this nipple is screwed a 2x1½-inch tee with all the stock to the bottom of the thread inside the 1½-inch portion removed, and into this opening is



EMERY-WHEEL HEAD

driven a piece of 1½-inch pipe about 9 inches long.

Rivets were then driven as shown and the whole made solid, then sawed through with a hack saw. The clamps will be seen at each end of the pipe to take up the wear, since enough clearance is left between them for a quantity of backing. The difference between the size of mandrel and the 1½-inch hole allows a quantity of babbitt to be poured inside.

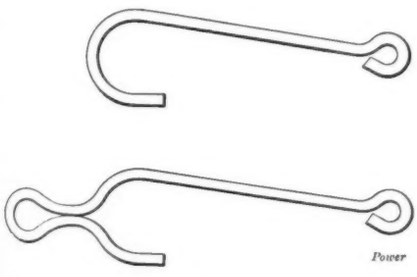
As will be seen the device makes a rather attractive head, and a good-sized wheel may be used thereon.

LLOYD V. BEETS.

Nashville, Tenn.

An Indicator Hook

In indicating engines and compressors, I was always more or less handicapped in attaching the indicator hook to, or detaching it from, the arm on the crosshead. Sometimes I would get hold of an indicator on which I could stop the drum without touching the hook by means of a clutch. Even in such cases I preferred to operate the hook unless the engine was a high-speed one. Ability to do the trick comes to us with practice, but in different amounts. Some can manipulate the hook with apparent ease, while others, myself included, find it to be more or less of a difficulty. Many times the hook has slipped and gone flying around the engine.



THE ORDINARY AND THE IMPROVED INDICATOR HOOK

It was after an experience of this kind, a little more strenuous than the ordinary, that I hit upon the form of hook shown in the lower part of the figure; the ordinary form is shown in the upper part.

In use, I regulate cord length, etc., in the ordinary manner. To attach the hook to the arm on the moving crosshead I proceed as follows:

I take hold of the hook by the extension on the end, and pull out the cord and stretch it just beyond the extreme travel of the crosshead arm. I then lower the hook until the cord rests lightly on the moving arm and, letting the cord wind up slowly, I soon reach a point where the arm runs right into the hook. When it does this I simply let go and the indicator is running.

To take the hook off, I grab the extension on the hook, the rod running back leaves the hook free and I simply let the cord wind up on the indicator drum.

This is a very simple affair and can be made in a few minutes. It is worth a trial.

JOHN BAILEY.

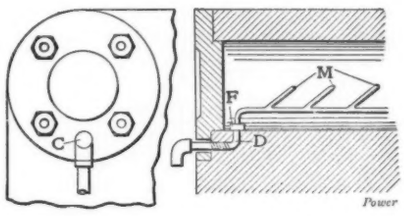
Milwaukee, Wis.

Improving Corliss-valve Lubrication

Some of our Corliss engines give trouble in the way of valve lubrication, especially those which were built for a lower steam pressure than that under which they are now working.

The following improvement will be found valuable for getting over the trouble.

In the figure, a Corliss valve is shown



CORLISS VALVE WITH ADDITIONAL OIL GROOVES

with additional oil grooves cut in it at *M*. These grooves are connected to a pocket *F* which fits over a hole drilled in the cylinder wall at *D*. A ⅛-inch pipe *C* is tapped in as shown, and connected to a force pump.

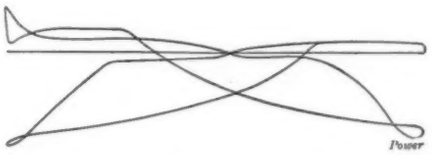
By this arrangement, perfect lubrication can be secured. If necessary, a film of oil can be forced in which will raise the valve off the seat.

C. R. MCGAHEY.

Sheffield, Ala.

Indicator Diagram for Criticism

I wish to submit the accompanying indicator diagram for criticism. It was taken from the low-pressure cylinder of a tandem compound engine running non-



DIAGRAMS FROM LOW-PRESSURE CYLINDER

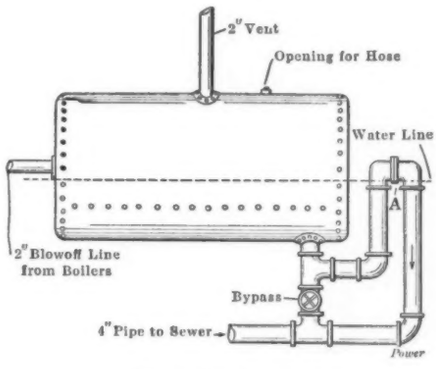
condensing, carrying the usual load. I would like to have the diagram analyzed and the different events in the stroke pointed out.

H. SETH.

Matihula, Mexico.

Blowoff Tank

No doubt many engineers have had trouble with the buried-in-the-ground type of blowoff tank. Upon blowing off my boiler one day, I noticed clouds of steam issuing from cracks in the floor and upon investigating found that the tank, which was buried under the floor, would puncture at almost any place I chose to tap it with a chisel. Consequently, after a few moments' thought I sat down and designed the tank shown in the accompanying sketch. This tank was made of ⅜-inch wrought iron, 30 inches in diameter by 60 inches in length. The



BLOWOFF TANK

blowoff pipe from the boilers enters one end at about the center, and is slightly above the line of bend *A* in the 4-inch discharge pipe; so that when the boilers are blown down, the water and steam always have empty space in which to blow. Naturally the vapor and steam pass out through the vent pipe and the water through the discharge pipe to the sewer. Attention is called to the arrangement being on the outside of tank, thus eliminating the trouble caused by the old method of having the outlet run through the side of the tank and held by lock nuts, with the pipe running nearly to the bottom of the tank to form the seal. After

installing this tank above the floor my troubles in this respect were over.

I might add that, in case of mud collecting in the tank, it can easily be washed out by inserting a hose through the opening in the top of the tank and allowing water to flow out through the bypass.

CHARLES P. WEAVER.

Buffalo, N. Y.

Cooling Condensing Water

In the summer of 1908 it was made apparent to the engineer of a mill in central Massachusetts that enough water for condensing and mill purposes could not be obtained from the company's pond. Taking advantage of the late business depression, with the aid of such help as the management was desirous of keeping employed, he constructed an unique system of water cooling, which during the summer of 1909 gave satisfactory results.

A concrete well 20x8 feet was built between the pond and the mill, and into this was sunk an old boiler, allowing a 5-foot drop to the rear. Water from the hotwell (well No. 2, Fig. 1) was piped so as to enter the top of this boiler (*A*, Fig. 2) and enough tubes were removed to allow the overflow *B* to be taken from the bottom. Through the tubes and around the shell of the boiler flowed a considerable quantity of water for manufacturing purposes. Leaving *B* the water divides and enters the 6-inch manifold, which is tapped for three rows of ¾-inch pipes, 50 pipes to each row. There the water zigzags through four headers while dropping 7 feet. The general arangement of this portion of the system is shown in Fig. 3. The area around the pipes is inclosed by spruce boards built in sections, with suitable baffles, and through this area, in countercurrent direction, sweeps the air from a motor-driven fan placed at the lowest level. From the lower manifold the water flows to well No. 1, Fig. 1. The feed water for the boilers was piped from the boiler well so as to be surrounded by the hotwell water as shown at *C*, Figs. 1 and 2. The drop from the outlet *A* in well No. 2, Fig. 1, to the inlet *B* in well No. 1 is 12 feet; thus the bank of pipes are always full of water.

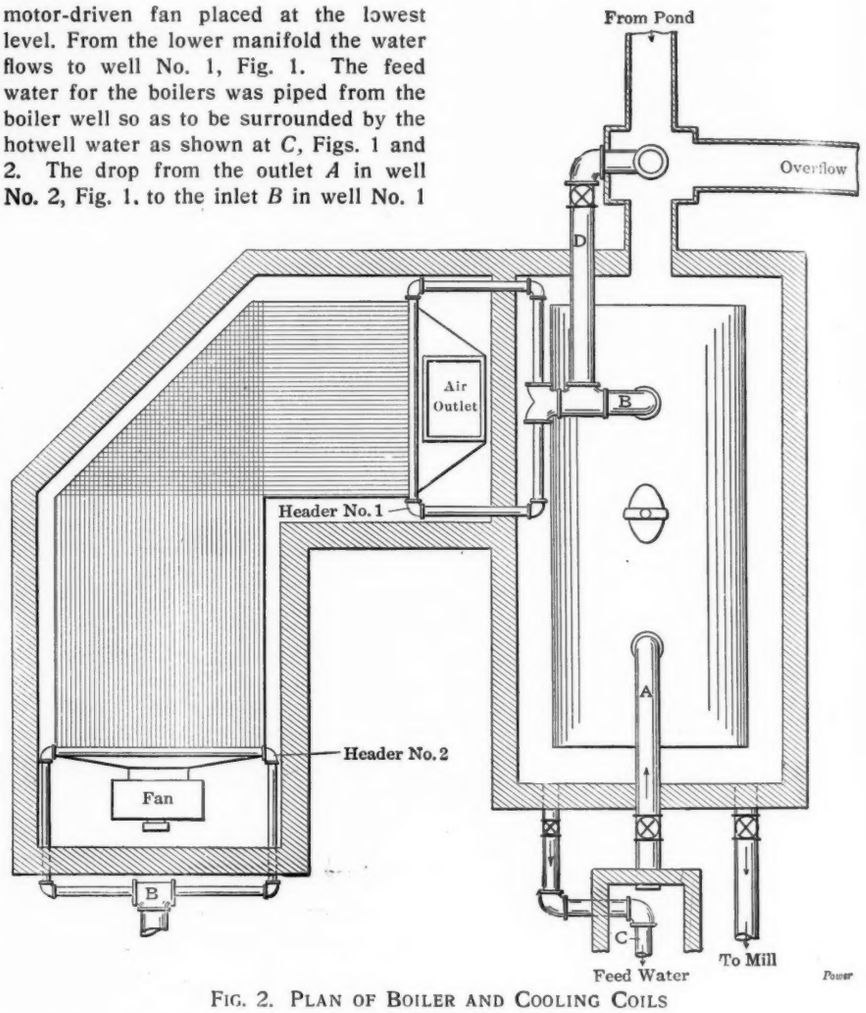


FIG. 2. PLAN OF BOILER AND COOLING COILS

After installing the system it was found that at times, owing to the intermittent use of the water in the mill, a large quantity was going to waste, and as this was consideraoly cooler than the water that flowed out of the old boiler, the line *D*, Fig. 2, was piped to an open flume, and the mouth placed at such a level as to admit any available water that the mill did not use. When water was thus admitted to the system, waste water flowed to the river from the hotwell only. The average temperatures secured were: Temperature of hotwell, 98 degrees; temperature on entering old boiler, 93 degrees; temperature on leaving boiler, 84 degrees; average temperature on entering header No. 1, 76 degrees; temperature of well No. 1, 68 degrees.

The condenser was installed to help the engine during the summer months when the load is heaviest. In winter the exhaust is used for heating purposes.

L. M. LESLIE.

Cambridge, Mass.

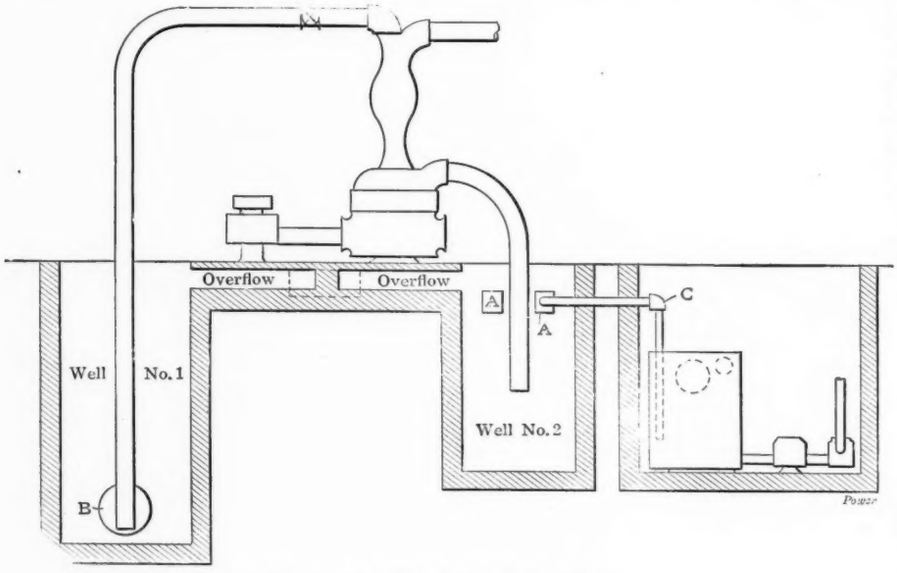


FIG. 1. ELEVATION SHOWING WELLS

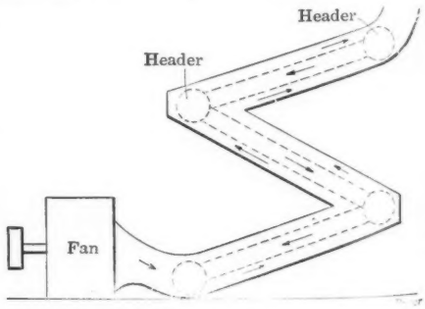
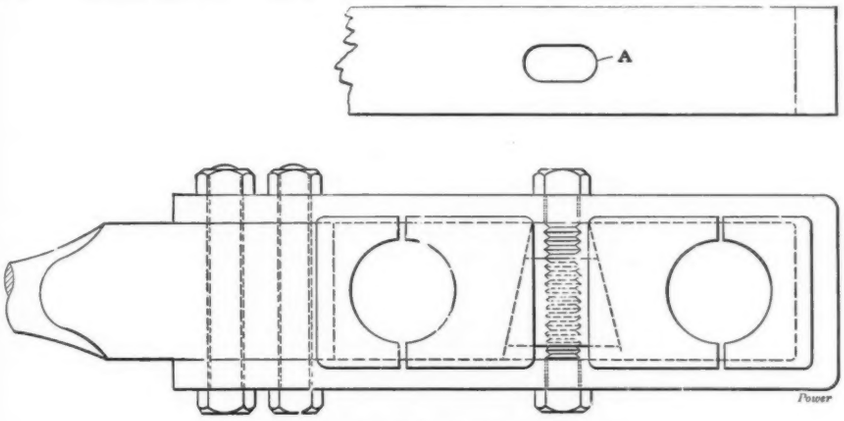


FIG. 3. ELEVATION OF COOLING COILS

Wedge Bolt Troubles

The accompanying sketch shows a style of double brass, used on an 11 and 20 by 14-inch cross-compound engine. It will be noticed that the wedge serves a double duty of taking up both brasses. After continuous wear the brasses had to be shimmed, and to accomplish this so that the wedge would take up equally, proved to be a hard task. The hole in the straps was just large enough for the wedge bolt, and this prevented equalizing. After slotting the strap, as shown at *A*, the wedge could equalize, thereby leaving no strain on the bolt and taking each brass up properly.



CONNECTING-ROD END SHOWING WEDGE

FRANK W. BELLINGER.

Havre, Mont.

Trouble with an Idler

I recently installed a 16 and 32 by 48-inch tandem-compound engine, belted to a 300-kilowatt alternator. The belt is two and one-half ply and made of leather. It is 35 inches wide and runs at a speed of 4000 feet per minute over an underneath type idler. Owing to lack of floor space and to the length of the engine it was necessary to belt the generator back, i.e., with the generator setting on a line behind the high-pressure cylinder, thus calling for an idler beneath the lower side of the belt as it was desired to run the engine over.

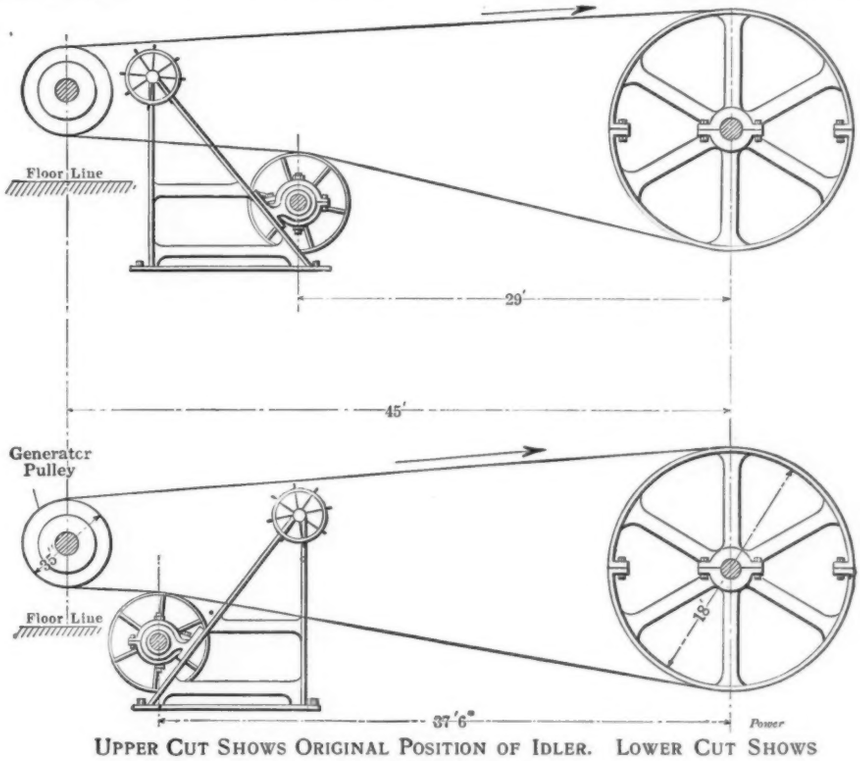
Under existing circumstances only a limited amount of time was available for placing the idler (which was to be set 48 inches below the floor line) and putting on the new belt. A 150-kilowatt generator was already connected up temporarily until the permanent machine could be belted up and had to be used up to a late hour on a Saturday night, thus giving part of Saturday night and Sunday only, in which to get the 300-kilowatt generator in service. This was a new machine and all the necessary precautions had to be observed, which in such cases usually consumes several hours.

Commencing work about midnight on Saturday the 150-kilowatt generator was moved out of the way, and we began cutting through an old concrete engine foundation to make a place for the idler. After going down about 3 feet we found that this was taking too much time and decided to fasten down the idler with timbers and concrete around them, the idler being set as in upper view. We finished getting the belt on and spliced by midnight Sunday and started up Monday noon. All went well until the generator began to take a load, then the belt began to travel over to one side. The idler was quickly adjusted, but the belt kept going to one side and no amount of adjusting could keep it in the center; raising the idler pulley only made matters worse. Thinking the belt had too much slack, I decided to shorten it, but this did not improve matters much. Something had to be done; to lower the idler was out of the question as we could not spare the time. So it was decided to turn the idler around as in lower view. This was done and up to the present time no more trouble has been experienced.

I attribute the trouble to too much wrap of the belt on the idler pulley. Setting the idler lower would have accomplished the same result.

W. F. COX.

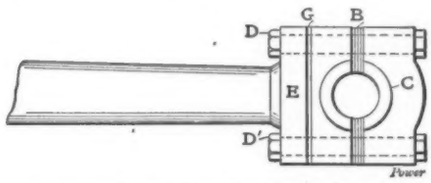
Natchez, Miss.



UPPER CUT SHOWS ORIGINAL POSITION OF IDLER. LOWER CUT SHOWS INVERTED POSITION

Improved Connecting Rod End

In the figure is shown a neat design of connecting-rod end and also a meritorious feature for taking up lost motion by taking out the requisite number of thin backing shims *B*. The babbitt ring *C* may be renewed when necessary to keep the pin from wearing the brasses. The bolts *D* hold the brasses to the end *E*.



CONNECTING ROD SHOWING SHIMS

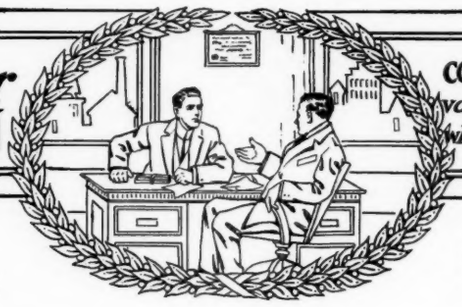
An improvement could easily be made by dividing the end of the rod at *G* and inserting a number of shims. With this arrangement, the length of the rod between the crosshed and crank-pin centers could easily be kept in accurate adjustment.

The improvement is more especially designed for the crank-pin end but with the necessary modifications it would be equally as good for the crosshead pin.

LLOYD V. BEETS.

Nashville, Tenn.

SUBJECTS *under* DISCUSSION



COMMENT, CRITICISM, *and* DEBATE *upon various* ARTICLES, LETTERS *and* EDITORIALS *which have* APPEARED *in* PREVIOUS ISSUES

Newton's Law Suspended?

In Fig. 3 of the original article, there are two forces in operation, the air blast acting vertically upward and the weight of the ball acting downward. The result, from the data given, is that the ball is suspended 8½ inches above the blower outlet.

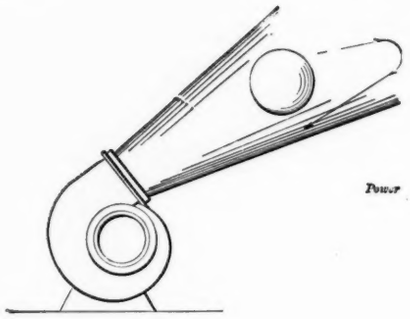


FIG. 1

In Figs. 1 and 2 of the original article, there are three forces at work, those due to the air blast and the weight of the ball and some force tending to keep the ball from dropping out of the stream. It is this last component which calls for elucidation.

It is stated that the ball does not stay in the middle of the stream. If it were placed there it would probably follow the path shown by the arrow in Fig. 1, herewith presented, first shooting along with the blast, then dropping vertically and returning obliquely as the effect of the air blast became less until the point of critical conditions of balance was reached.

Said Wilbur Wright before the Western Society of Engineers at Chicago on September 18, 1901: "* * * in a wind blowing 26 miles per hour up a steep hill we made glides in which the rate of descent was less than 2 feet per second and, during the larger part of this time, while the machine remained exactly in the rising current, there was no descent at all but even a slight rise. If the operator had had sufficient skill to keep himself from passing beyond the rising current, he would have been sustained indefinitely at a higher point than that from which he started." He then showed an illustration, of which Fig. 2 is a rough copy, of the 1900 machine soaring alone, that is to say, with no passenger, in a wind of 35 miles per hour on the face of a steep hill. The two operators on the ground prevented the machine from being blown away. Explaining the figure in Mr. Wright's own words, "It will be seen that the machine not only pulls upward but also pulls forward in the direction from which the wind blows, thus overcoming both gravity and the speed of the wind. We tried the same experiment with a man in the machine, but found danger that the forward pull would become so strong that the men holding the ropes would be dragged from their insecure foothold on the slope of the hill."

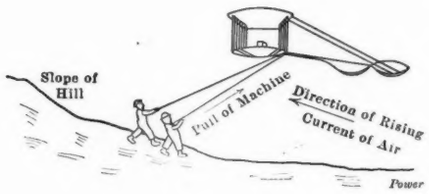


FIG. 2

It is evident that in the case of the ball shown in Fig. 2 of the original article the resultant of all the forces must be vertical, that is, not only is the force due to the weight of the ball overcome but also the horizontal forces are exactly balanced. At this point I cannot do better than quote Mr. Wright again. He says: "A kite is soaring when the string stands exactly vertical, thus showing that there is no backward pull. This phenomenon is exhibited only when the kite is flown in a rising current of air. In principle, soaring is exactly equivalent to gliding, the practical difference being that in one case the wind moves with an upward trend against a motionless surface, while in the other the surface moves in a downward direction against motionless air. The reactions are identical." Thus the india-rubber ball under discussion soars in a rising current of air which exerts a force capable of counterbalancing the downward pull on the ball due to gravity.

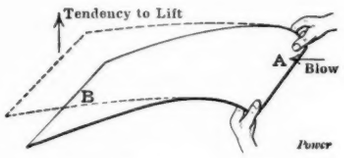


FIG. 3

Another factor which undoubtedly influences the problem is the vacuum-creating action going on behind the ball in the direction of the air blast. The air pressure due to the blast will be greatest along the center line of the blast; as the boundary of the cone shown in Fig. 1 is approached, the velocity and effective pressure of the blast are decreased owing to the lag caused by air friction at the outskirts of the stream, just as in a river the velocity of the water at the banks is less than that of the mid-stream due to the friction between the water and the banks. At first blush, then, it would seem that, the pressure being greater on the upper surface of the ball than on the lower surface and the ball being suspended below the center line of the stream, the ball must drop because of the differences in these pressures.

Now take a sheet of writing paper by the forefinger and thumb of each hand, as in Fig. 3, and blow horizontally at the arched surface at *A* and along the upper side of the paper. The back of the paper *B* will rise as indicated by the dotted lines. Further, if the back quarter of the paper is hinged, as in Fig. 4, and if the experimenter blows again as before, the hinged portion will tend to rise as shown, apparently in direct opposition to the action of the current of air.

Apply this state of affairs to our ball. It seems evident that this action together with the lifting action of the blast on the under side of the ball is enough to overcome the downward pressure of the stronger air currents on the upper surface and to keep the ball at rest. If the above explanation will hold water, the effects of the cardboard *F*, shown in the original Fig. 2, the obstructions *C* and *D*, and the finger at *E* are evident.

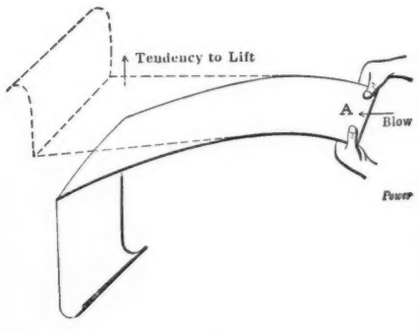


FIG. 4

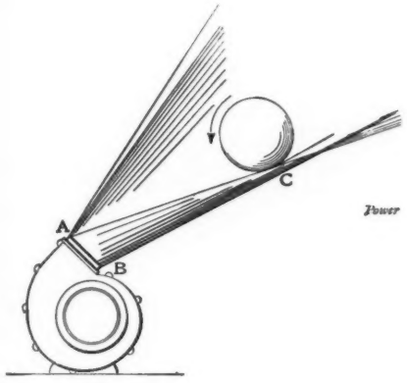
An academic investigation of a problem of this nature would involve night-

mare mathematics for the printing of which the editors would probably be proceeded against by the public prosecutor. The eddying actions of water are but vaguely understood; those of air, ——!

JOHN S. LEESE.

Manchester, England.

My explanation of the phenomenon described in the February 22 number is as follows: The ball is light and the force of air from the blower overcomes its weight. The ball will revolve rapidly in the direction indicated by the arrow, I



AIR CURRENTS FROM BLOWER

suppose, and thus it is kept up in the air. As indicated in the accompanying figure, the current of air, at the blower outlet, is a little heavier at *A* than at *B*. The upper part of the current will cross the lower part at *C*. The current shown by the light shading at the top is of lower pressure.

G. A. JANICKE.

Louisville, Ky.

Double Eccentric Engine

I have observed in late issues of POWER interesting articles on double-eccentric Corliss engines. There appears to be an idea held by many of the writers that because a Corliss engine is fitted with two eccentrics, the steam valves should always be set with negative lap. This is wrong. I have operated many Corliss engines with two eccentrics and always set the steam valves with a small amount of lap except when the duty of the engine is to drive a three-high blooming mill where the load will vary from no load to overload within a few seconds. In these cases my practice has always been to set the valves with a negative lap so as to get a maximum range of cutoff and still have valves release or trip. When the steam valves are set with a small amount of lap, the range of cutoff is generally sufficient for economical operation.

In a 30-inch high-pressure cylinder fitted with one eccentric, the lap of the steam valves will probably be from 3/8 to 7/16 inch in order to advance the eccentric a sufficient amount to obtain an early release and not have too much lead. With two eccentrics, the steam lap can be cut down to 1/8 inch, and the exhaust eccentric advanced to secure the desired early release.

When an engine has to be handled by hand this method is usually more convenient as one can always be sure that the steam valves will not release should the wristplate be moved too far.

H. H. RYDE.

Monessen, Penn.

Safety Appliances

I have read with interest numerous letters recently published in POWER regarding safety appliances.

No appliance is of any worth unless it actually does what it was designed to do. There is no better evidence that the safety appliances of the present day do this than the fact that they are sold and stay sold. Many of them are installed on 30 to 60 days' trial. If they perform their functions satisfactorily when they are new, there is no reason why they should not continue to do so if properly cared for and kept in adjustment.

I have known engineers (?) to have fine apparatus placed in their charge which became, in a very short time, worthless through their own carelessness or ignorance. The best Corliss engine can be made to be as wasteful as the common, old, throttling-governor, slide-valve type, through maladjustment and improper handling, and it would fall just as far short of its intended efficiency as any safety appliance would under similar conditions. But it would be hard to find anyone ignorant enough to assert that the Corliss engine is an unreliable machine.

I think engineers should more fully appreciate the importance of safety appliances and the necessity of their proper care and upkeep, for each new appliance is only another step toward the perfection of steam-engineering science.

H. R. ROCKWELL.

Mt. Vernon, Ill.

Overloaded Engine

In the February 15 number of POWER, W. C. Schueler tells us of an extreme case of overload, and asks for advice. We will assume that the valves are set correctly on both the high- and low-pressure cylinders, and that other conditions are favorable. If I were in his position, I would send to the makers of the engine and find out the highest speed at which the flywheel could be run with safety and speed up the engine to that speed. At the same time I would change the pulley on the jack shaft to a larger diameter in order to keep the speed of the shaft the same as before. In this way, by increasing the speed of the engine, I would be increasing its capacity. Also I would cut down the amount of compression in the cylinders to the lowest possible quantity. If it could be accomplished, I would raise the boiler pressure, and in this way obtain a greater mean effective pressure in the engine cylinders.

For the sake of economy, the purchase of a new engine would be the most desirable move to make. After considering the conditions he describes, I think that it would be but a very short time before a new engine would have paid for itself.

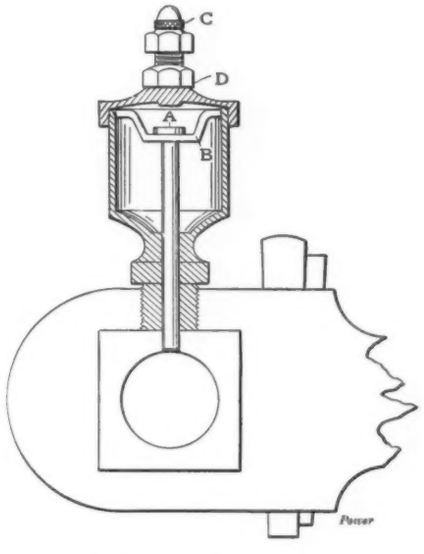
A. C. WALDRON.

Lynn, Mass.

Grease as a Lubricant

In the February 15 issue M. Kennett has an article on "Grease as a High-speed Engine Lubricant." I am a firm believer in the success of grease on crank pins, but I do not think very much of Mr. Kennett's cup. The copper stem resting and pounding on the crank pin will wear itself away and also injure the pin. He does not have a locknut on the adjusting screw, which is liable to work loose, causing the grease to feed too fast and the cup to get empty before the end of the run.

The cup which I am using is, I think, far superior to his. It is shown herewith. The plain brass pin in the center does not rest on the crank pin but comes



DESIGN OF GREASE CUP

into close proximity to it. The head of the pin *A* rests on the spider *B* which carries the pin and hence keeps it up off the crank pin. The feed is adjusted by the screw *C* and locked in position by nut *D*. I am using several of these cups and would not want anything better. A 12-ounce cup will run for a week at 18 hours a day if it is properly adjusted.

JAMES E. DICK.

Hanover, Penn.

Centrifugal Pumps

In the issue of March 1 appeared a letter from W. C. Stephens describing two centrifugal-pump tests which he ran and asking for comments and suggestions.

From the diagrams printed it appears that the suction pipe enters the pump casing at the periphery of the wheel and the discharge pipe is taken out at the center. This is, of course, exactly opposite to the principle upon which centrifugal pumps operate and is, I presume, an error made by the one who drew the sketches.

The discrepancy between the gage readings of the two tests is not surprising as from the figures it appears that the gage was applied in one test at a point about half way between the pump and the jet box and in the other it was applied at the further end of the box, beyond the last jet. In the first case the gage showed a pressure sufficient to force the water through half the length of the 1½-inch discharge pipe and out through the ¼-inch jets, while in the second case it showed the pressure in the box which need merely be sufficient to force the water through the outlets.

The method of water measurement was too crude to expect any great degree of accuracy but it would be natural to suppose that the pail method would have shown lower rather than higher results due to the friction in the hose. Either the meter read high or the water in the pail was not weighed accurately. Water meters for tests of this sort are unsatisfactory at best. A speed of 1500 revolutions per minute is not excessive for this type of pump.

H. Ross Calloway.

New York City.

Criticism of Diagrams

In the March 8 number, R. L. Blackmore submits some indicator diagrams for criticism. Those in Fig. 2 are certainly a great improvement over Fig. 1. The valve setting seems to be good. The negative loops show that the engine is running under a very light load and I would suggest that Mr. Blackmore gradually reduce his boiler pressure, taking diagrams at intervals, until the expansion line, at release, shows one or two pounds above the back pressure.

If he does not care to reduce the boiler pressure and the load on the engine is fairly steady, it might be a good plan to run with the throttle only partly open and try that "superheating-by-wire-drawing" method as explained in Power some months ago.

James H. Campbell.

Detroit, Mich.

In the issue of March 8, Mr. Blackmore presents diagrams for discussion. Judging from general appearance, it is safe to say that the diagrams in Fig. 2, show an improvement on those in Fig. 1. There is a better distribution of steam and all of the events of the valves appear to be earlier, in fact, a little too early. If the eccentric were moved back a trifle there would be a more vertical admission line, later cutoff and later release.

It appears that the steam pressure is too high for the load if the diagrams represent working conditions. The cutoff is too early and the steam consequently expands below the atmospheric line and this causes the piston to do negative work against the back pressure on the return stroke.

Moving the eccentric back, dropping the steam pressure or increasing the load ought to improve the economy and operation of the engine.

J. W. Blake.

New York City.

Of the diagrams in the March 8 issue, those shown in Fig. 2 show marked improvements, and are very good no-load diagrams, but full-load diagrams would give better indications of the actual condition of Mr. Blackmore's engine.

The diagrams in Fig. 2 show more lead and less clearance, later exhaust on the crank end, good expansion and cutoff, higher initial pressure and equalized admission on both ends.

C. A. Gochenour.

Ozark, Ark.

The diagrams are good as far as valve setting goes. For better economy, I would put a larger jack pulley onto the jack shaft, and decrease the speed of the engine. This would lengthen the cutoff so that the terminal pressure would not be any higher or lower than the back-pressure line. Although the cutoff will take place later, the amount of coal burned will be less because the engine will make fewer revolutions and the condensation due to the longer cutoff will be much less in proportion as the engine cylinder will be kept nearer the temperature of the steam.

The diagrams show high back pressure. Mr. Blackmore may be heating the building with exhaust steam. If such is the case, I would advise him to put in a standard vacuum heating system, or at least a vacuum pump on the return of the system. He will find that he can do the heating with one or two pounds of back pressure where now it looks as though five or six pounds were required; and since every pound of back pressure multiplied by the constant of the engine represents the horsepower which is resisting the engine, it is easy to see that the expense of installing a vacuum pump would soon be paid for. I speak from personal experience with just such an installation. The fuel expense was decreased 30 per cent. simply by putting a pump on the end of the heating system.

Mr. Blackmore shows good judgment in having the compression run up nearly to boiler pressure. It is evident that he does not believe in wearing out a coal shovel too fast.

A. C. Waldron.

Lynn, Mass.

Diagrams in Fig. 2 show that the load is better divided and that all of the events are well timed; but as the load on the engine seems to be unduly light, it is difficult thoroughly to analyze the diagrams. A lower boiler pressure would make a later cutoff at a lower initial pressure and remove the loops which occur and also give better economy and, in general, make a quieter running engine. The lead, none too great for a heavy load, is sufficient for the load as shown.

I would suggest that the boiler pressure be lowered and that a diagram be taken with a spring of larger scale so that the expansion and back-pressure lines would be more clearly shown. By constructing the theoretical expansion line, Mr. Blackmore could get a fair idea as to whether the piston or valves were leaking. This condition seems to be indicated by the rapid drop in pressure. A loop indicates a back pressure which consumes power and would tend to make the engine noisy. If the piston and valves are all right and the load as shown by the card is normal, I would run the engine with a lower boiler pressure if possible, as it is much underloaded.

William C. Thorne.

Vineland, N. J.

Never Open or Close a Stop Valve Suddenly

In the March 1 number I noticed a footnote on page 405 which conveyed the admonition given above.

We are reminded, from time to time, by engineering handbooks and periodicals to take precautions of this nature, but it was only a few months ago that I was reprimanded by an old and apparently experienced engineer for closing a boiler blowoff valve slowly. He insisted that a blowoff valve should be closed as quickly as possible. When I asked him why, he said so as to prevent any scale or other obstruction catching in the valve and preventing it from being completely closed. I have often wondered since, how many valves he has ruined by closing them rapidly. From my point of view, it is positively dangerous to close a blowoff valve suddenly when there is any appreciable steam pressure in the boiler. A waterhammer has often gone through

stronger resistances than those offered by a blowoff valve.

If there is an excessive quantity of loose scale coming out from the boiler, the quick-closing method might have to be resorted to, but under ordinary circumstances I would prefer to let out a slightly greater quantity of water than run the risk of suffering the consequences of waterhammer. If anything should stick in the valve while it is being closed, it usually can be cleared by opening the valve a little wider for an instant.

LLOYD V. BEETS.

Nashville, Tenn.

To Clean the Heater

Mr. Shutt might take his heater apart and with a cutter, attached to a flexible shaft, bore out the tubes. The cutter should be shaped like a sharp-nosed reamer—only a little more pointed so that it will feed into the scale. After boring a while the loose scale will have to be blown out from time to time. The tubes are probably of exact size throughout so that the flexible shaft will no doubt follow the bends. The edge of the cutter should be rounded a little so that it will not cut into the tubes when going round a bend.

THOMAS GORDON.

Cheyenne, Wyo.

In the issue of February 22, W. S. Shutt asked for information regarding the removal of scale from heater tubes.

I have obtained good results with the use of caustic soda; where the scale was on the outside or inside of the tube, the caustic soda would loosen it in good shape. However, I have never used it in a bent-tube type of heater.

The strongest solution which I ever used was one pound of caustic soda to 20 gallons of water. I used the solution hot. It never foams, and will not do any harm if some of it gets into the boiler. The heater should be filled with the solution and allowed to stand for 24 hours, after which it should be washed out with a hose. I should be very glad to hear from Mr. Shutt as to what success he meets if he uses my suggestion.

Caustic soda will burn if any of it is dropped upon the flesh. To neutralize any effects it may have, rub the flesh with oil or grease.

O. L. SHERMAN.

Duluth, Minn.

I am in charge of a central hot-water heating plant, and heat the water with exhaust steam which passes through three closed heaters. These heaters became filled solid with lime.

I tried acid and about everything else but could not remove the lime. Finally, I took off both heads and removed the tube sheets. I then made a cement basin long and wide enough to hold a number of tubes and gave the tubes a bath of acid. This cleaned them thoroughly. In removing the tubes from the tube sheet I found that it could not be done without rupturing the ends of the tubes, but by cutting off ½ inch on each end of the tubes and then annealing the ends I could, by countersinking one of the heads enough to make up for the shortening of the tubes, replace the old tubes and save the company about $200 per heater.

I have a water softener at this station and I cannot see how Mr. Shutt's heater can fill with lime if his softener is doing its work.

CHARLES WOOD.

Ada, Ohio.

Is the Salesman a Nuisance?

In the issue of POWER for March 8, I read with much interest W. F. Meuner's article on "Writing for Catalogs," and having once been a "knight of the grip" I feel compelled to answer his article, both as to how to write for catalogs and as to the salesman being a nuisance.

If he had, when writing for a catalog, fully explained his reason for doing so, his position in the plant, made use of the company's letterhead and inclosed postage, his request would, no doubt, have been granted regardless as to whether the cost of the catalog was three cents or three dollars. Most houses, realizing that the present assistant engineer is a future chief, do not feel inclined to refuse such a request and thereby chance the loss of future business. If a follow-up in the form of a salesman arrives, whether or not desired, an explanation all around usually will dispose of the matter to everyone's satisfaction.

Mr. Meuner states that salesmen are a nuisance. Emphatically, he is wrong. Most engineers of my acquaintance are unanimous in declaring them a blessing. I would have agreed with him had he stated that the salesman who makes only the first sale for what there is in it, regardless of the damage to the reputation of the house and the damage to the plant, is a nuisance. To the engineer, the salesman is a necessity.

Again, Mr. Meuner states that any engineer who can read and write and who subscribes to technical papers knows exactly what he wants without the aid of a salesman and orders by letter or telephone. Wrong again! Some catalogs, especially those showing large lines, only describe articles in a condensed form. A salesman calls and, in the language the engineer understands, fully describes the article in question in a few words.

The engineer and the salesman always have been good friends, working for each other's mutual benefit, and we hope that this condition of affairs will remain so. As a great many salesmen once were in charge of power plants they have the gift of recognizing a man's ability better than others, and many engineers have been placed in more lucrative positions through salesmen's aid. During their travel, salesmen visit so many plants that they are veritable walking encyclopedias and have often made suggestions which have made the engineers' lives more gladsome.

Who is more welcome on a blue day than a bright, witty, salesman, who, after being told that there is nothing needed in his line, draws forth his trusty Havana (?), says, "Smoke up," and remains to talk of mechanics, politics, etc.

F. W. FISCHER.

Knoxville, Tenn.

Engine Room Floors

In the issue of POWER for March 1, the editorial "Engine Room Floors" should be of interest to stationary engineers in general, because oil spots on concrete floors around engines give the room an untidy appearance, regardless of the cleanliness of the engines themselves.

In a power house in which I worked, the floor around each of four engines and one air compressor was given a coat of good mineral paint mixed with varnish, once a month.

When the night oiler got through wiping up in the morning, he used the oily waste to wipe up the painted floor. This gave a neat and clean appearance to the floor which lasted throughout the day watch.

FREDERICK WAGNER.

Chicago, Ill.

Tanbark as a Fuel

I have followed with much interest the subject of burning tanbark and note that most all of those who write upon it have steered clear of what is to me the most troublesome feature, the emission of sparks from the stack.

In spite of the best combustion obtainable in a dutch-oven furnace with a large combustion chamber built for either coal or refuse, I find that a considerable quantity of sparks will pass through the flue to the stack, from which they will flow in a manner similar, in my conception, to the eruption of a voclano.

I have made evaporation tests which compare in efficiency and capacity (I mention capacity as it is of vital importance in my plants) with those tests which have been printed in POWER. But always there were sparks in greater or lesser quantity.

I am willing to spend time and money to look over a plant where they get 70 per cent. capacity from boilers built for burning refuse and coal. I would like, also, to hear what any readers may have to say about handling the sparks.

J. F. CARRIGAN.

Port Edwards, Wis.

Steam Liberating Surface

The writer was much interested in the editorial on the above subject that appeared in the issue of March 29, and also the article that brought it forth. There is evidently no very fast rule regarding the amount of liberating surface necessary to provide for the delivery of a given volume of steam in boiler practice, and it is also evident that none can be fixed because there are so many varying factors entering the question that they cannot be well provided for in a rule.

In many types of boilers it is almost impossible to even make a shrewd guess as to just what surface can be properly called liberating surface, and in nearly all boilers this surface is worked at widely varying rates; two exceptions to this are the Hazleton, or Porcupine, boiler and the Manning boiler. The Hazleton boiler, of, say, 200 horsepower capacity, has about 7 square inches of liberating surface per boiler horsepower and the Manning type of about the same capacity has 15 square inches of such surface. The writer is not familiar with the operation of the Hazleton boiler, but the Manning type can be operated on good water at 50 to 100 per cent. above rating with practically no entrainment and produce superheated steam. It is evident that the limit of restriction of liberating surface (where the liberation is uniformly distributed over the surface) has not been reached in the Manning boiler; the effective liberating surface in the Manning boiler is considerably in excess of that present in many types of water-tube boilers.

The method of taking off the steam from a boiler and the quality of the feed water used are very important factors affecting the entrainment of water, as has already been pointed out in the editorial. Dry pipes and similar attachments intelligently applied have remarkable effect in some instances. In boilers of the water-tube type, entrainment of water is very liable to occur where vertical or very nearly vertical tubes deliver steam directly into drums from which steam is drawn, even if relatively large liberating areas are provided, unless baffle plates are used to impede the geyserlike progress of the mingled steam and water ejected from the tubes. Evidently an important factor affecting the ability of a given amount of liberating area to serve a fixed amount of heating surface, which was not mentioned in the editorial, is the steam pressure at which the boiler is operated. The writer has never heard this point brought out as affecting the liberation in a steam boiler, but it is very evident that it is an important factor, for the agitation produced by the liberation of steam at the surface of the water must be directly proportional to the volume of steam delivered in a given interval of time; with variable pressure, the volume of steam produced by a given amount of heat is by no means constant, therefore the operating pressure must be taken into account if any definite information is to be obtained on the subject. To illustrate how much variation there is in the volume of steam delivered by a square foot of heating surface when transmitting heat at a rate of 3330 B.t.u. per hour or on a basis of ten square feet of heating surface to a horsepower, the following table has been prepared. The water is assumed to be delivered to the heating surface at a constant temperature of 212 degrees Fahrenheit.

Steam pressure in pounds.	Weight of steam generated per square foot of heating surface. Pounds.	Volume of steam generated per square foot of heating surface. Cubic feet.
14.7	3.45	90.9
50	3.35	21.9
100	3.32	12.7
125	3.30	10.5
150	3.29	8.9
175	3.28	7.8
200	3.27	6.9
225	3.26	6.2
255	3.25	5.5

It will be noted from this table that the volume of steam delivered at 100 pounds pressure is 1.63 times the amount delivered at 175 pounds pressure, although the heating surface is transmitting the same amount of heat in both instances; the weight of steam delivered is almost constant. The pressures selected for comparison are by no means the extremes in practical plant operation.

S. F. Jeter.

New Haven, Conn.

Second-hand Boilers

The editorial in the March 8 number on "Selling Second-hand Boilers" cannot be too highly commended as its burden is for safety.

Who buy those second-hand boilers is not such a puzzle after all, for, if investigated carefully, many of them may be found in plants owned by very respectable parties in every way except in their respect for the importance of reliable power apparatus. But they may be excused when it is remembered that some men are prone to try to procure everything they can, "dirt cheap."

As to the condition of those resold boilers found in many plants the owners of which would look upon a new boiler as expensive and not to be thought of, we may expect to find them of all degrees of safety; "good, bad and indifferent" would be an appropriate way of summing up.

"Jones" had been a man of business affairs in a certain city for a number of years, doing contract work where very little power was used, up to two years ago, when he became interested in a plant five miles out from the corporate limits.

The plant needed to be enlarged and another boiler of perhaps 60 horsepower was to be installed. "Profiting" by the "advice" and insistence of "a friend" who had an old, second-hand boiler of about the size wanted, the "friend's" boiler was accordingly bought and installed. When filled with water it was found to leak so badly that it was impossible to use it for steam generation.

It must be said, however, to this man's credit, that a new boiler was bought and installed.

Lloyd V. Beets.

Nashville, Tenn.

Position of Throttle

Many of those who have written on this subject are agreed that the throttle wheel should be out of line with the flywheel, but seem to feel that the handling of the engine will be interfered with.

In a big cotton mill where I worked for some time, we had an 800-horsepower, tandem-compound engine equipped with a ¾-inch bypass. In handling that engine, I never saw the throttle used; always, it was the bypass. In every way it was superior to the throttle, quicker, surer and easier.

Is not this the way out: turn the throttle stem out over the cylinder, and put a small bypass on the valve side for handling?

William E. Dixon.

Hudson, Mass.

Erosion of Brass Pipe by Flue Gases

In regard to Mr. Geicrin's inquiry in the March 8 number as to the cause of the brass feed pipe being worn away, I would say that flue gases will always act in this way on metals, and on brass more quickly than on other metals.

Any pipe that lies in the direct path of the gases will be worn away much more rapidly than the flue walls or the boiler. The gases coming in contact with the metal cause a chemical reaction to take place.

I have seen this illustrated by the pipes which supplied cooling water to an internal bearing in a fan for induced draft. These pipes were in the fan inlet and in the direct path of the gases. The pipes first used were galvanized and lasted about 18 months. Then brass pipes were put in. These were badly eaten away in eight months. After this, extra-heavy iron pipes were put in; these were the longest lived of any. The size of the pipes was ½ inch.

G. H. Kimball.

Southbridge, Mass.

Turbine Power Plant Farthest North

7500-horsepower Steam Turbine Plant Installed at Varanger, Norway, to Furnish Current for Treatment of Iron Ore. Yearly Output 600,000 Tons

Up north, at Kirkenaes, amid the snow and ice below the North cape of Norway, is located a modern steam-power plant. Here the polar nights last from November 27 to January 16, and during this period the sun never rises above the horizon. In such a place an uptodate steam plant which is farther north than any other power station in the world is equipped with the latest development in prime movers; large steam turbines of De Laval make.

This installation was not made necessary by the long nights, but because iron-ore deposits were discovered about eight years ago on the Tasvik peninsula, Varanger, Norway. This ore was such that shipment before treatment or concentration was impracticable. The percentage of iron varies from about 34 to more than 50 per cent., and there is an estimated

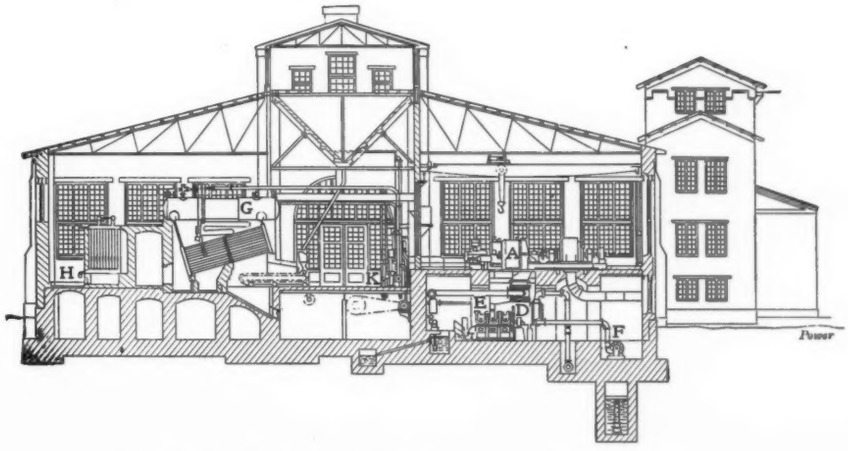


FIG. 2. ELEVATION OF TURBINE AND BOILER ROOMS

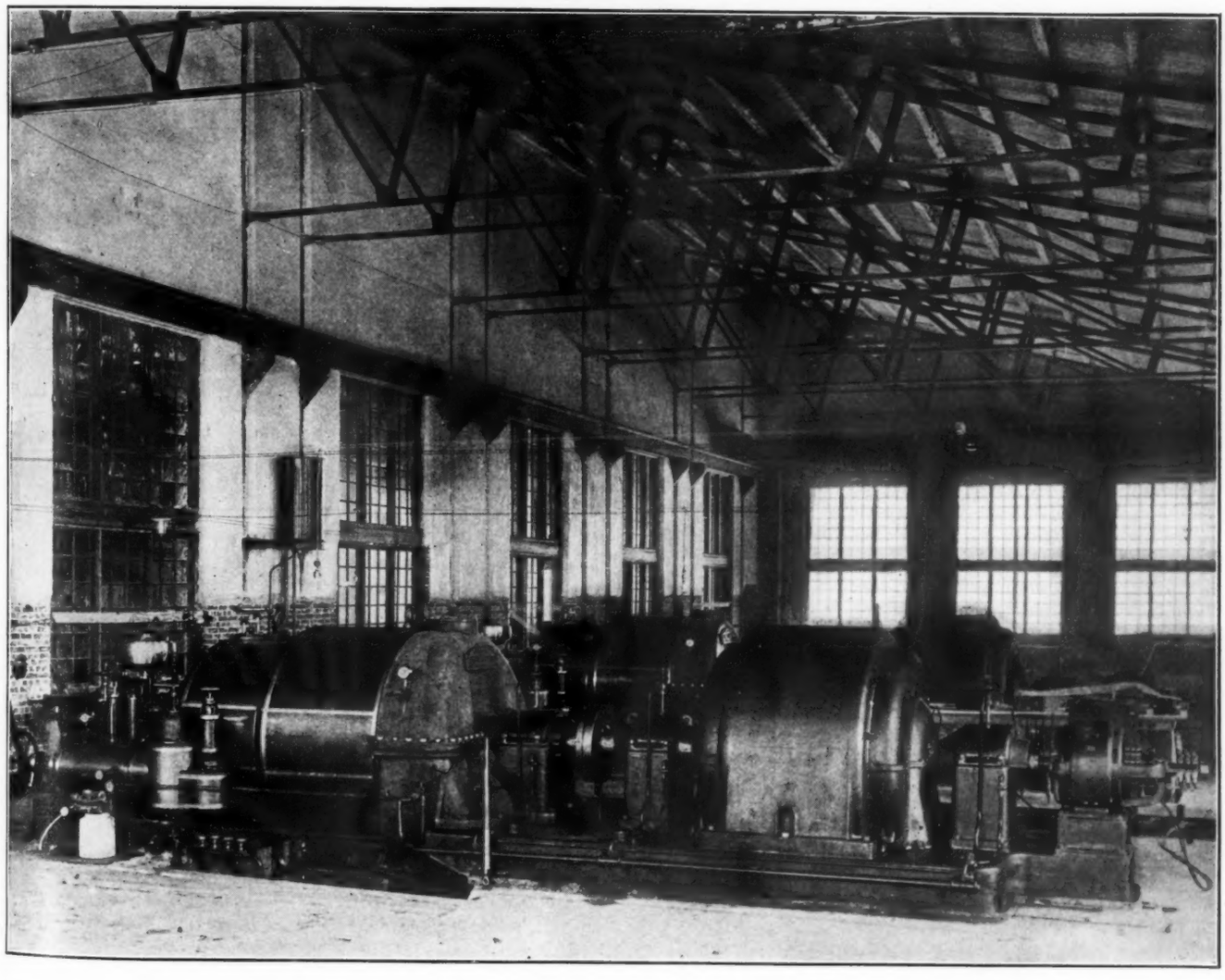


FIG. 1. INTERIOR OF TURBINE ROOM

minimum amount of available ore of about 400,000,000 tons, which will be mined at a yearly output of about 600,000 tons of magnetically treated product.

The boiler plant, Fig. 4, consists of five 500-horsepower Babcock & Wilcox water-tube boilers, with space for two more of equal capacity. These boilers are set separately, with a passageway between. There are two economizers placed at the rear of the boilers as shown in Figs. 2, 3 and 5. The illustration, Fig. 5, gives a good idea of the method employed in bricking them in, as well as their general arrangement.

The flue gases after passing through the two economizers escape to the atmosphere through two brick stacks. The third stack, shown in Fig. 3, is yet to be built, and will not be necessary until the two additional boilers are installed. The boilers are also equipped with superheaters and mechanical stokers. An arrangement somewhat out of the ordinary, in this country at least, is that of the double set of chain stokers under each boiler. It will also be noticed that the furnaces are of the Dutch-oven type.

There are four high-pressure De Laval Zeta pumps, each of 250 brake horsepower. They are placed in a pit as shown in Figs. 3 and 6. Several small Zeta pumps are used for various purposes besides two steam-operated boiler-feed pumps. The condenser air pumps are located in the basement and are motor driven by means of noiseless chain belts.

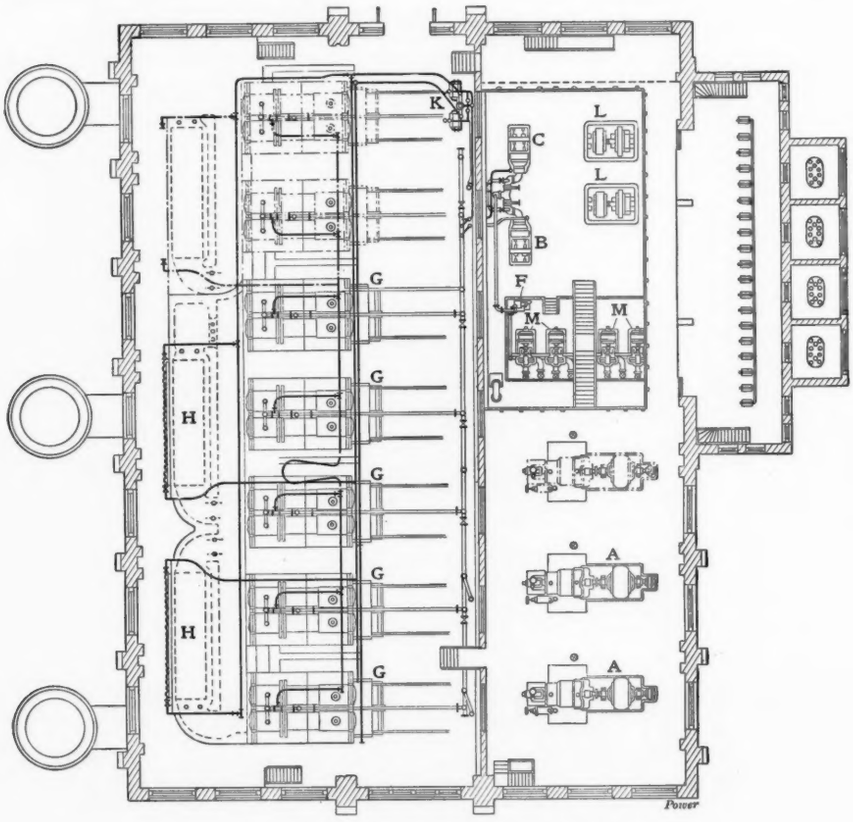


FIG. 3. PLAN VIEW OF THE POWER PLANT

This treatment, together with the current necessary for operating the various machines, requires considerable power, hence the necessity of the power station. The brick building housing the steam and electrical machinery has a roof constructed of iron framework covered with wood which in turn is protected by a metal roofing.

The turbine room contains two 3750-brake horsepower De Laval multistage steam turbines, each direct connected to an 850-volt three-phase alternating-current generator, developing a maximum of 2625 kilowatts; and space has been reserved for an additional unit. On the lower floor are located one 360-brake horsepower De Laval steam turbine direct connected to a 240-kilowatt three-phase alternating-current generator, and one 180-brake horsepower turbine direct connected to a 120-kilowatt generator. There are also two motor-driven generator sets. These units are used for excitation purposes, two units being held in reserve. Fig. 1 shows the two large turbine units.

By referring to Fig. 3, the general layout of the entire power plant may be seen. Fig. 2 shows an end elevation of the power plant, also the space devoted to the boiler room and the position of the pumps and condensers in the basement.

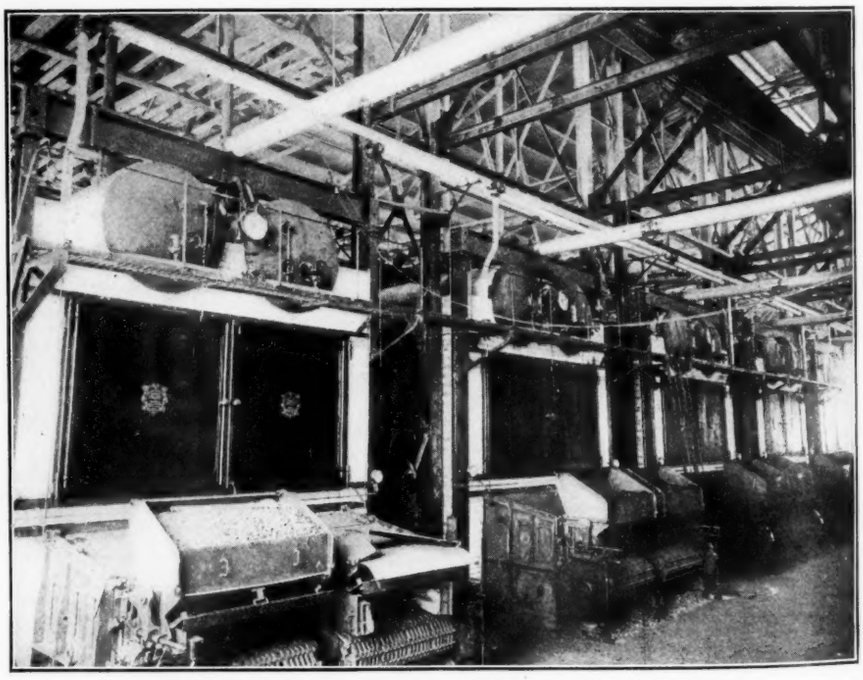


FIG. 4. VIEW OF BOILER ROOM

Graphite has been recommended as a boiler-scale preventive. It is claimed that it will not only prolong the life of boilers, but also greatly increase their steaming capacity. The method of using it is simple. In a certain plant, for the first 30 days, one pound of graphite was mixed with a pail of water and this amount was pumped into each 100-horsepower boiler every night. After that period this quantity, used once or twice a week, was found to effectually prevent any new scale from forming. It was also found that the old scale gradually loosened up and dropped off, leaving the heating surface free of scale.

Test of Boiler for Quality of Steam

In the selection of a boiler, one of the most important factors to be considered is the quality of the steam. It is desirable to have the steam as dry or free from water as possible. This is especially true in cases where superheat is used, for with a smaller amount of water in the steam a superheater of lesser capacity may be used and a lesser number of heat units will be required to obtain the desired degree of superheat.

Thoroughly realizing this, the Erie City Iron Works have had extensive tests conducted to determine the quality of the steam which the Erie City boilers are capable of delivering under various rates of steaming.

The results of tests conducted under the direction of Prof. R. H. Fernald, of the Case School of Applied Science, Cleveland, O., are given herewith.

The boiler used was a standard Erie City vertical water-tube rated at 258 horsepower. The principal data are as follows: Length of 48-inch drum, 16 feet; length of 40-inch drum, 11 feet 10 inches; number of tubes, 242; length of tubes, 13 feet 5/8 inch; heating surface of tubes, 2480 square feet; heating surface of drums, 104 square feet; total heating surface, 2584 square feet; width of grate, 118 inches; length of grate, 58.5 inches; area of grate, 48 square feet; steam-holding capacity, 140 cubic feet; water-holding capacity, 338 cubic feet; area of steam-liberating surface, 45 square feet.

The apparatus for determining the quality of the steam consisted of a standard Carpenter, throttling calorimeter and a Thomas, electric-steam calorimeter. These instruments and all thermometers and pressure gages were carefully calibrated before the tests and, with the exception of the electrical instrument, their calibration was checked after the completion of the tests. In the application of the calorimeters special care was taken to avoid error due to radiation by lagging all connections heavily with hair felt. A Thomas sampling instrument was used to supply both calorimeters. This instrument is designed so that steam may be taken from three distinct places in the pipe.

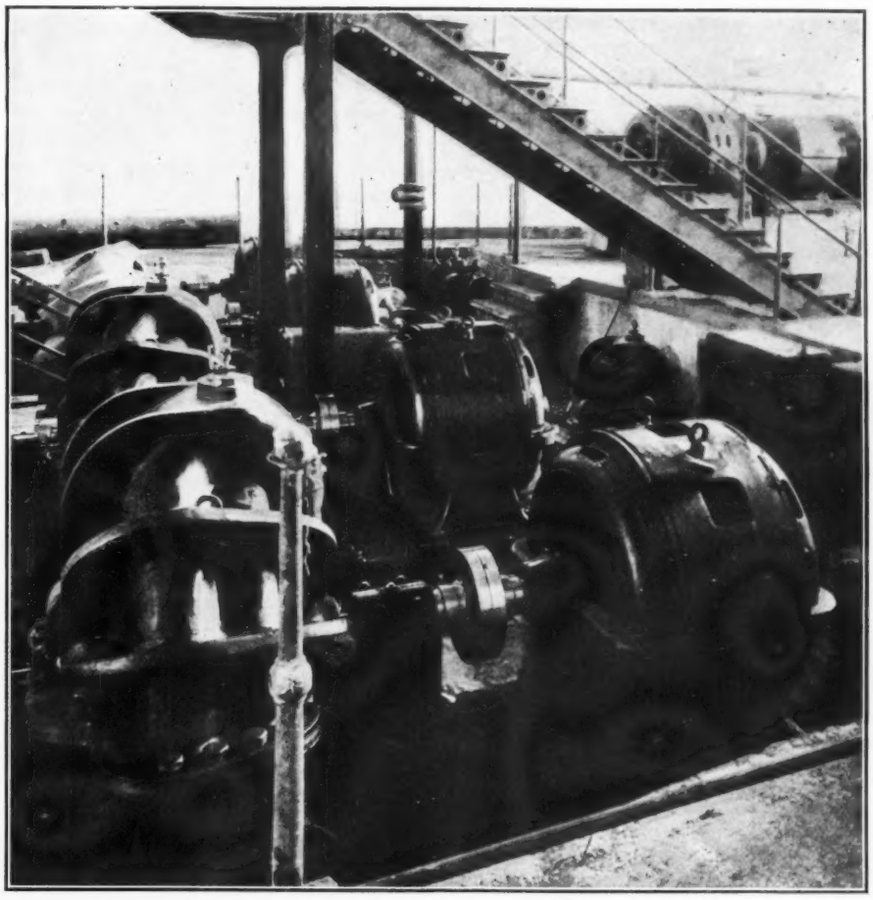


FIG. 6. ARRANGEMENT OF MOTOR-DRIVEN CENTRIFUGAL PUMPS

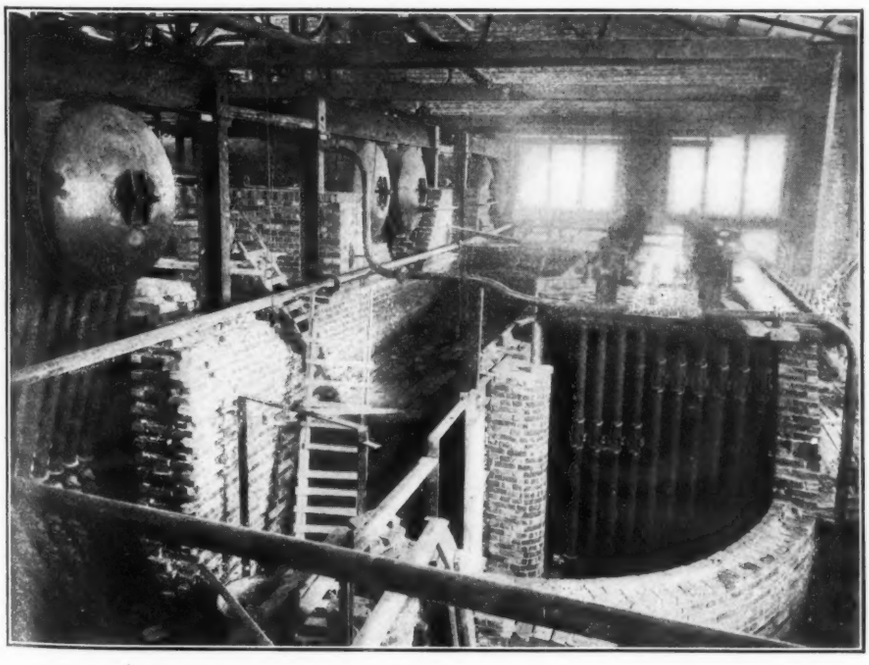


FIG. 5. SHOWING METHOD OF INSTALLING ECONOMIZERS

The arrangement of the apparatus is diagrammatically shown in the figure. The three points from which samples were taken are indicated in the 4-inch steam riser at *A*, *B* and *C*.

BOILER AT NORMAL RATING
AVERAGE PER CENT. OF DRY STEAM.

Sampling Point.	Throttling Calorimeter.	Electric Calorimeter.
A	99.7	99.1
B	99.7	99.3
C	96.6	99.2

A series of samples of the steam was taken at 15-minute intervals during the time between 10:45 a.m. and 2 p.m., while the boiler was being operated at approxi-

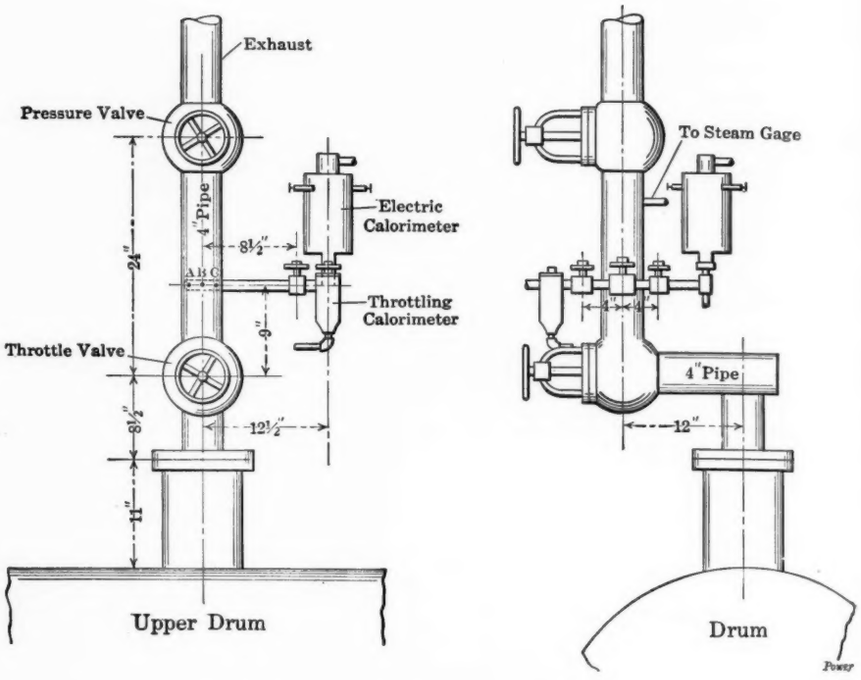
mately normal rating. The averages of the results secured are given in the accompanying table.

Another series of samples was taken when the boiler was being operated at about 40 per cent. above rating. The duration of this test was two hours and forty-five minutes. The samples were taken at 15-minute intervals as in the previous case. The averages of the results obtained follow:

BOILER AT 140 PER CENT. OF RATING.
AVERAGE PER CENT. OF DRY STEAM.

Sampling Point.	Throttling Calorimeter.	Electric Calorimeter.
A	99.7	99.5
B	99.8	99.5
C	99.7	99.6

The electric calorimeter gave results uniformly lower than those obtained by the throttling instrument. The steam was drier, apparently, when the boiler was operated above rating. This has been found frequently to be the case and is said to be due to the higher temperature at which the boiler setting and attachments are maintained while the boiler is being forced above its rated capacity.



DIAGRAMMATIC ARRANGEMENT OF CALORIMETER

Modern Type of Corliss Air Compressor

Machine Designed to Give Efficient Service with High-speed Corliss Engines. Speed of Air through Ports Reduced and Increased Economy Obtained

BY S. RICE

It has been the common practice of air-compressor manufacturers to build machines to operate at speeds corresponding to the old Corliss engine speeds, with the result that when an air compressor was driven by a Corliss engine, the latter, on account of the limitations of the air end, was operated at a speed of 25 per cent. or more less than that which is now universally recognized as the best Corliss engine practice. In other words, the development of air compressors has not kept pace with that of Corliss engines. The air compressor described herein has been designed to meet the need of a machine to give highly efficient service at the same speeds at which Corliss engines are now generally operated. With this new compressor both the steam and air end of a steam-driven compressor are operated with equal efficiency, while the capacity of the compressor itself is greatly increased. In the new design, moreover, by a suitable arrangement of the inlet and discharge openings, the speed of the air through the ports, which is one of the vital points about a compressor, is not only no greater than in the older designs, but in most cases is considerably less, indicating an increase in economy over that attained by the slower-speed type.

The construction of the air cylinders is shown in the accompanying illustrations. A reference to Fig. 1 shows the arrangement of the inlet and discharge valves, the former being located below the piston level and removed from the heat zone, thus insuring the least possible increase in the volume of the incoming air due to a rise in temperature. In the end view, Fig. 1, it can be seen how much larger are the port areas provided, the entire surface of the cylinder head being available for the discharge valves, while the inlet valve is located just below the bottom of the cylinder. The water space around the barrel may be seen in Figs. 2 and 3. Fig. 2 is a cross-section through the middle of the cylinder, showing the relative proportion of water space. The working barrels are not cast in one piece with the cylinder casting proper but are separate, the cylinder casting being accurately bored and the liner accurately turned to fit and forced into place, the space between the liner and the outer walls of the cylinder forming the water jacket. This construction insures freedom from casting strains. Large cleaning holes are provided, so that the water spaces may be

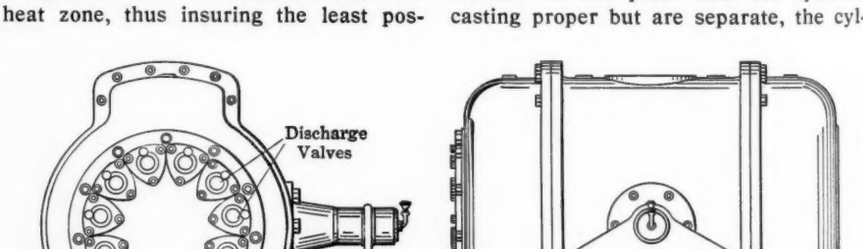


FIG. 1. ARRANGEMENT OF INLET AND DISCHARGE VALVES

thoroughly cleaned out whenever necessary. Air passages, both for suction and discharge in the cylinder casting, communicating with the cylinder heads

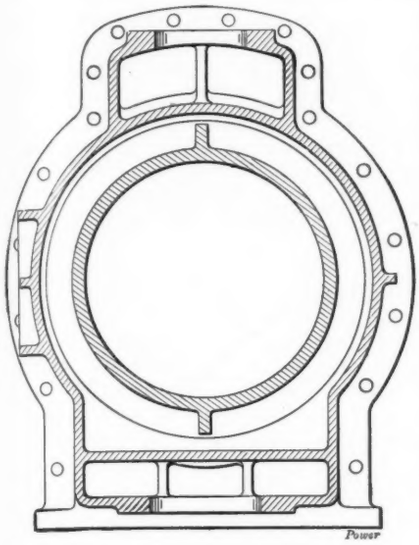


FIG. 2. SECTION THROUGH CENTER LINE OF AIR CYLINDER

through proper openings, bring the suction and discharge from both heads to the center, thus simplifying the piping. The cylinder castings are of strong,tough iron, and the working barrels or liners are made of a special mixture of hard, close-grained iron in order to secure maximum durability with minimum lubrication. The liners can be removed and new ones put in should it ever become necessary or desirable on account of wear.

The entire cylinder head being given up to the discharge ports, it is impossible to water jacket the heads; but, on account of the greatly increased radiating surface of this type of head, this is unnecessary. The water jacketing of air cylinders removes so little of the heat of compression as to avail nothing in the actual economy of air compression. The only object in water jacketing air cylinders is to keep the cylinder cool enough for proper lubrication, and the results of long experience in building different types of compressor cylinders, with and without water-jacketed heads, show clearly that if the air-cylinder barrel itself is thoroughly water cooled, the cylinder walls cannot be raised above low, ordinary working temperatures.

As indicated in Fig. 1, the air cylinders rest on, and are secured to substantial sole plates, which are firmly bolted to the foundation. These sole plates extend out under the valve gear, and have raised edges, so as to catch all oil drips from the valve gear.

The pistons for the air cylinders are of the same design as those used in heavy-duty steam cylinders. The piston rods are made extra heavy, of the best-quality, selected, open-hearth steel, and are accurately turned, ground and polished. In steam-driven compressors the air-piston rods are coupled to the steam-piston rods by threaded clamp couplings made of the best quality of steel. The steam-piston rods of steam-driven machines and the air-piston rods of power-driven machines are fastened to the crossheads by screw threads and jamb nuts. This method of construction permits of an accurate adjustment of the pistons in the cylinders to equalize the clearance and make it as small as possible by running the air pistons close to the cylinder heads.

Many years' experience has demonstrated the superior merit of Corliss valves for compressor service. The Corliss valve is especially well suited to compressor inlet valves, as it affords a quick, free opening and admits the air in a thick, unbroken stream, while at the same time a very small proportionate surface of heated metal is exposed to contact with the incoming air. Corliss valves are not suited for discharge valves in single-stage compressors nor in the high-pressure cylinders of two-stage compressors where the absolute terminal pressures are over three times the absolute initial pressure, as they then have to open too late in the stroke to get a sufficiently free discharge. Therefore, the builders of these machines, the Allis-Chalmers Company, use as a standard the arrangement of valves shown in Fig. 3; Corliss valves for inlet and plain, single-beat, poppet valves for discharge. The inlet valves are driven by an eccentric on the main shaft, and, by means of the wristplate mounted on a stand on the side of the cylinder, they open and close quickly but have a slow movement when the ports are covered and the valves are under pressure. This is characteristic of the Corliss valve gear. The inlet ports are of ample size, short, and direct, and the air is guided into the cylinder by an easy curve, thus reducing the entering friction and insuring the complete filling of the cylinder with as little loss in pressure and at a temperature as near that of the outside as is possible.

The discharge valves are of the drawn-steel cup type and open automatically when the pressure in the cylinder equals the discharge pressure. These valves are light and strong and work quietly and

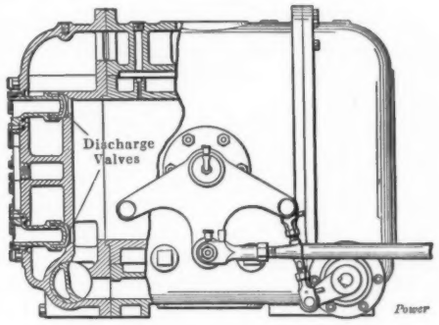


FIG. 3. PART SECTION SHOWING INLET AND DISCHARGE VALVES

without chattering. They are easily accessible for inspection and may be readily removed for cleaning and put back again without trouble. The inlet valves may also be removed and replaced without disturbing the connections or the adjustment of the valve setting.

In steam-driven compressors, the steam and air cylinders are usually arranged in tandem, the particular arrangement adopted in any case, depending upon the style of the compressor, the type of air cylinder and the conditions of operation. One of the common methods of placing the cylinders is shown in Fig. 4, but there are many cases in which it is advisable to reverse this arrangement. The builders of these machines state that they give careful consideration to each individual case and use such a design as will best meet the required operating conditions in the plant requiring the installation.

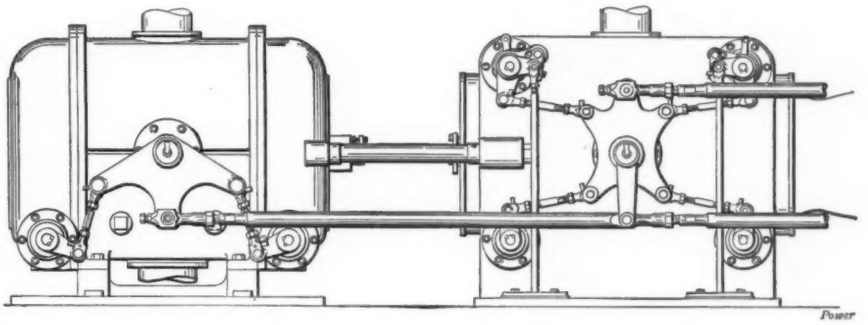


FIG. 4. AIR AND STEAM CYLINDERS

In 1907, when the maximum output of both anthracite and bituminous coal was recorded, the total production amounted to 480,363,424 short tons, valued at $614,798,898, of which 85,604,312 tons were Pennsylvania anthracite and 394,759,112 tons were bituminous, semi-bituminous and lignite, with scattered lots of anthracite and semi-anthracite.

25,000 Horsepower Exhaust Steam Heater

There has recently been installed at the Ninety-sixth street power house of the Metropolitan Street Railway Company, of New York City, a 25,000-horsepower Hoppes exhaust-steam feed-water heater containing 2500 square feet of heating and purifying surface. It is 15 feet 3 inches in length, 90 inches in diameter and contains 192 annular trough-shaped pans, each having an area of 13 square feet, over the edges of which the feed water trickles (from the upper to the lower ones) in a bath of steam a part or all of which is condensed, depending on the relative quantities of each.

This heater, except for its size and capacity, is not essentially different from the regular exhaust heater of the Hoppes company.

In this installation, Fig. 1, the exhaust steam enters at the left-hand end, passing through an oil eliminator having herring-bone deflecting slats which separate the oil-laden condensation from the steam and allow it to pass to the main chamber of the heater, where, surrounding the overflowing drip pans, it is either all condensed or heats all of the feed water to its own temperature, while the oil and water go off through a special overflow pipe. If the supply of exhaust steam is more than is needed the uncondensed excess escapes to the atmosphere through the vertical pipe at the left.

Feed water is admitted through a balanced regulating valve controlled by a ball float which maintains a constant water level in the heater at a predetermined hight regardless of the demands of the pumps which are supplied by the horizontal pipe leading from the bottom near the right-hand end.

After passing the regulating valve the water is first divided into three streams, each of which is again divided and led to the six distributing pans which overflow to the heating and purifying troughs underneath.

The electrical output of the station ranges from 18,000 to 38,000 kilowatts, and when carrying full load all of the exhaust steam from the auxiliaries is condensed, heating the feed water to 206 degrees Fahrenheit. The condensation which is returned to the boilers with the feed water amounts to a saving of from 1½ to 2 per cent. of the feed water required. This coupled with increase in the temperature amounts to $15 per day with the normal load of 18,000 kilowatts and to $25 in extra-heavy days when the load approaches 40,000 kilowatts.

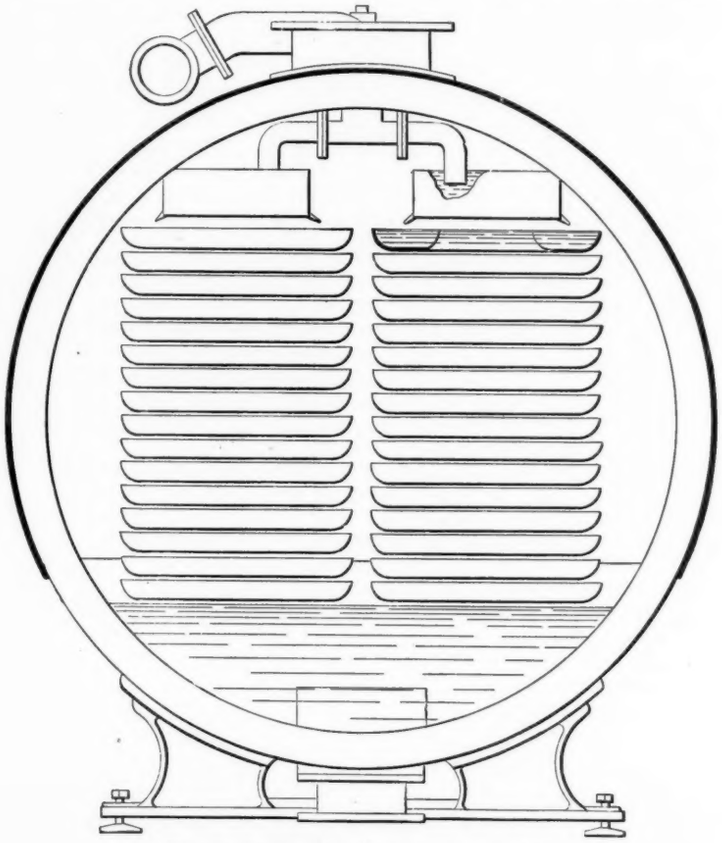


FIG. 2. SECTIONAL VIEW THROUGH HEATER

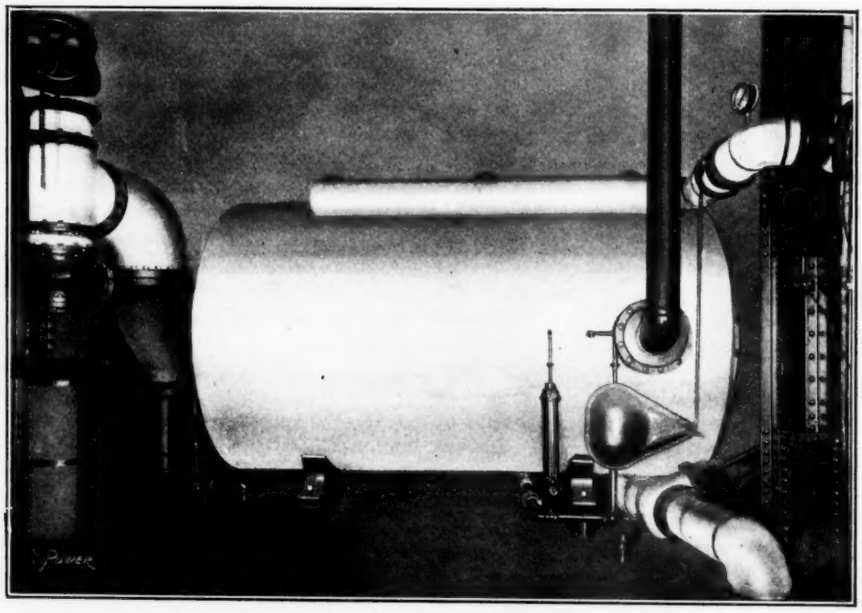


FIG. 1. HOPPES 25,000-HORSEPOWER HEATER INSTALLED IN METROPOLITAN PLANT

The allowance of only about one-tenth of a square foot of pan surface per horsepower is a measure of the extent to which the subdivision of the water and its almost perfect intermingling with the steam is carried, and the results obtained under the present conditions show that with ample water and steam supply 1,000,000 pounds of water per hour may be satisfactorily heated.

Fig. 2 is a cross-sectional view of the shell, showing the arrangement of distributing pipes, pans and purifying troughs.

The heater is supported on cradles at each end of which there is an adjusting screw by means of which it can be kept on an even keel, providing for a uniform overflow from all of the troughs and permitting readjustment.

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April 12	37,000
April 19	37,000
April 26	36,000

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Power and The Engineer

Editorial

Steam and Gas Power Fuel Economy

On another page we print the gist of some recent remarks by Louis M. Ellison to the effect that the fuel economy of steam power so closely approaches that of gas power that the former can never be superseded by the latter. We quite agree that gas power is not likely to drive steam power off the face of the earth, but we cannot agree with Mr. Ellison's fuel-economy figures, which put the fuel cost of steam at less than one-fifth cent per horsepower-hour and that of gas (producer) power at a cent and a half per horsepower-hour. Such a comparison is absurdly partisan.

In the first place, we do not know of any plant, distant from a coal mine, in which a thousand pounds of water are evaporated with twelve cents' worth of coal, although Mr. Ellison says that is the outside cost in the loop district of Chicago. In the next place, he puts gas-producer efficiency at sixty-five per cent. and gas-engine efficiency at twenty-three per cent., whereas there are scores of producers showing seventy-five and engines showing twenty-five to twenty-eight per cent. heat efficiency.

But, to get away from thermodynamic obscurities and deal with plain, common lumps of coal and engine-shaft power, any good producer and engine of five hundred horsepower will yield a brake horsepower on one and one-quarter pounds of pea coal or one and one-half pounds of bituminous coal per hour, including standby losses. How many steam plants of one thousand horsepower or under are doing or can do that or anything like it?

Mr. Ellison, indulging in a little rash prophecy, said that the over-all efficiency of the present gas-power plant does not equal that which will ultimately be realized by the steam plant of the future. That is conceivable, but it is not at all conceivable that gas-power machinery will stay where it is while steam equipment is being developed up to his predicted efficiency of twenty-one and one-half per cent.

In short, Mr. Ellison allowed well-meant optimism to lead him beyond the limits of logic. In the very nature of things, a steam plant of ordinary size cannot be expected to compete with a gas-power plant in fuel economy. It is possible, but not at all probable, that we shall never get beyond fifteen hundred horsepower per cylinder with gas engines, but it is irrational to suppose that steam plants in general will ever be as economical in fuel as gas plants when the units are anywhere near equality of output.

Mr. Ellison's reference to gas engines operating on illuminating gas were irrelevant, because such engines are not commonly used in important sizes. The engines in Atlanta and San Francisco are monumental exceptions.

Reducing Gears for Marine Turbines

When the propeller was first introduced it had to be run so much faster than any available steam engine that gears had to be used between the engine and the propeller to bring the motive speed up to that required by the screw. Now the shoe is on the other foot. The steam turbine, while it offers many advantages for marine work in its simple high-speed form, loses many of the points in its favor if it must be built in large diameters and with many stages to keep down its rotary speed. The solution of the problem is being sought in restoring the gearing between the motor and the screw to reduce the speed of the turbine to that of an efficient propeller.

An attempt has lately been made by the Turbine Works Company to adapt the turbine in this way to slow cargo vessels. The "Vespasian," a cargo vessel of 4350 tons with a 14-foot propeller, was fitted with two Parsons turbines in series. At the after end of each of the turbines a driving pinion is connected with a flexible coupling between the pinion shaft and the turbine, the pinions being geared into a wheel which is coupled to the propeller shaft. The gear wheel is 8 feet 3½ inches pitch circle, having 398 double helical teeth with a circular pitch of 0.7854 inch. It is of cast iron with two forged-steel rims shrunk on. The total width of the face is 24 inches; inclination of teeth, 20 degrees to the axis. The pinion shafts are of chrome-nickel steel 5 inches diameter pitch circle with 20 teeth 0.7854 circular pitch. The ratio of the gear is 19.9 to 1. The teeth of the pinions and the gear are lubricated by means of a spray pipe extending the full width of the face.

This gear transmitted satisfactorily

over a thousand horsepower and permitted the use of a maximum diameter of 3 feet for the high and 3 feet 10 inches for the low pressure, and lengths of 13 and 12 feet 10 inches for the high and low respectively, resulting in a saving in weight of 25 per cent. and an increase in efficiency of 20 per cent. over the triple-expansion reciprocating engines which it displaced.

Theory and Practice

The old, old controversy between theory and practice will not down. Like the poor, it is ever with us. The hard-headed practical man, who works amid the grime and other discomforts of the erecting gang, who overcomes difficulties as they arise—the man who gets results—is inclined to make light of his well groomed brother who comes honestly by his brain fag in a handsomely furnished office, or over a drafting board. The operating engineer, lacking perhaps in familiarity with logarithms, the slide rule and the T-square, but whose orthodoxy is sound as to maintenance of service and low operating costs, is not inapt to turn up his nose at the sleek consulting engineer who planned the system over which he presides.

Far be it from us to deny that too often these sentiments are reciprocated. The office man, conscious of the severe training he has undergone—much of it severely practical—confident in the knowledge of a hundred similar plants—knowing their strength and their weakness—is prone to underrate the experience and ability of the man in overalls. And in so doing he sometimes comes to grief.

All honor to both these types. The world has need of them, and will honor and reward them. For neither is complete alone. The one must have the other to supplement—to round out—his work, to make of it a symmetrical whole.

And is not the difference between these types—once so marked—growing less and less as the years go by? Yonder erecting boss in working togs, alert of eye and bearing, quick and resourceful, handy with tools, is concerned with the erecting and adjusting of a mammoth high-duty pumping engine. Or it may be a monster steam turbine; or a 15,000-kilowatt generator. Later he will start the unit, and test its efficiency. More than likely he is a graduate of some technical school of renown, which taught him the dignity and the honor of labor. More and more the schools realize this, and the big shops find that the graduates they employ are the better for a few years of shop work.

The so called "practical" man—if he be of caliber worth while—finds that he becomes more resourceful and appreciative as he begins to think more—to reason things out, in short, to look upon the theoretical side of affairs. He has long known that certain things happen, and he is not content until he begins to know how and why they happen. So he studies books, attends lectures, reads his POWER, and familiarizes himself with the experiences of others. Perhaps he takes a correspondence course in some branch of engineering, or attends a convenient night school. He makes himself more valuable, and is intrusted with greater and greater responsibilities. In the terse slang of the day—he makes good. He may himself land in the office, or over the drawing board, before many years have passed.

We risk nothing therefore when we assert that the "technical" man must be "practical" to reach his highest usefulness. And the practical man cannot afford to ignore the technical or theoretical side of the material things among which he lives and moves and has his being.

After all there is no warfare between theory and practice. There can be no true theory which is not rigidly borne out when put to the hard test of practice. Nor can there be any practice for which there is not a sound and sufficient explanation—call it theory if you will. Sometimes they seem difficult to reconcile, but the fault is all our own. We jump at conclusions—we try false and unsound theories. Often our attempts to reduce theory to practice are incompletely, ignorantly or inefficiently made. Sometimes we lack a full understanding of the theory. But once it is thoroughly known, the practical results are as certain to follow as the night follows the day.

So thoroughly is this fact now established that it is trite to even mention it. And yet it sometimes helps our peace of mind to reflect again upon the common truths of life.

Chimney Insurance

A brick chimney costs anywhere from $1000 to $500,000 depending on the size of the chimney, the duty it has to perform and one or two other factors. A brick chimney is practically permanent; that is, it may reasonably be expected to outwear the plant it serves—barring accident.

The causes of accidents to which chimneys are most susceptible are explosions, wind, earthquakes and strokes of lightning. Chief among them are strokes of lightning.

Of six hundred chimneys which one firm of chimney builders erected, five hundred and fifty-two were equipped with lightning rods; none of these have ever been damaged by lightning. Of the forty-eight not protected by rods, three have been injured by lightning. In one case, the cost of the repairs amounted to $3000, just seventy-five per cent. of the original cost of the chimney.

A lightning-rod outfit costs from $100 to possibly $1000, erected, depending on the kind of material used, the size of the chimney and the time at which the rod is installed. There are obvious reasons why it costs less to erect a rod at the time when the chimney is being built than at some later time. A reason not so obvious, however, is that unless the rod is put on while the chimney is being built, it never is put on until after the chimney has been struck, in which event there is added to the increased cost of the rod the item of repairs to the stack.

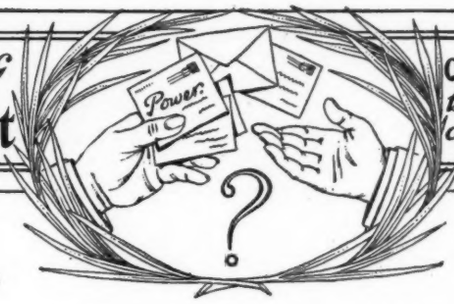
The purchase of a good lightning-rod equipment at the time when the chimney is contracted for may be considered a paid-up policy on the insurance of the chimney, for life, against damage by lightning. It is a good investment.

The facilities of the mechanical laboratories at Columbia University have been placed at the service of the editorial staff of POWER by Dr. Charles E. Lucke, who has them in charge.

A new step in the engineering branch of the United States navy was marked by the launching of the torpedo-boat destroyer "Paulding" at the yards of the Bath Iron Works on April 12. This vessel will use oil exclusively as a means of generating power, no coal being carried except for galley purposes, and is the first of our destroyer fleet to be thus equipped. Several foreign navies have long been using oil as fuel in their small craft, but the United States has been content to saw wood and profit by an extensive series of tests on land before committing itself to the use of any one type of burner.

According to recent reports, Johns Hopkins University proposes to take an advanced step in aiding higher education. It is proposed to raise a fund of two million dollars, one-half of which is to be used to remove the university from its present location to the new grounds at Homewood, N. J., and the second million to establish departments of scientific study and research and to enlarge the work of those departments which are already established. For example, a school of higher engineering is to be established, where graduates of technical schools and practising engineers may come and take up the research work which is so needed in the technical lines. The development of technical instruction has not kept pace with the marvelous growth of the country, and there has always been a scarcity of trained men. The school of higher engineering should be of material assistance in this regard and give the manufacturing interests of the country a desirable body of scientists and workers from which they may freely draw.

INQUIRIES of General Interest



QUESTIONS are NOT ANSWERED UNLESS they are ACCOMPANIED by the NAME and ADDRESS of the INQUIRER.

Drilling Glass

How can I drill or cut small holes in glass?

G. R. F.

Put a piece of brass tubing in the drill spindle, the diameter of the tube being equal to that of the hole desired. Revolve rapidly, and feed with emery and water. For making holes in thin glass, put a piece of stiff clay or putty on the part where you wish to make the hole. Make a hole in the putty or clay equal in diameter to that of the hole you wish to make, letting the hole reach the glass, of course; into this hole pour a little molten lead, and the piece will drop out. It is said that glass may also be readily drilled with an ordinary flat drill made as hard as possible, slowly revolved and liberally supplied with turpentine.

Lead of Steam Valves on Putnam Engines

What reason is there for giving a Putnam engine a different lead on the crank end from that on the head end?

N. L. W.

Owing to the angle which the connecting rod makes with the center line of the engine, the piston travels faster when leaving the head end than when leaving the crank end of the cylinder, and more lead is given to the head-end valve to insure full pressure on the piston at the beginning of the stroke.

Effect of Keying on Clearance

How is the clearance affected in the keying up of a solid-end connecting rod?

C. W. Y.

It would increase the clearance at one end of the cylinder and decrease it at the other unless the wear at both ends of the rod was equal and the adjusting wedges were so placed that the taking up of the wear at one end shortened the distance between the centers as much as it was lengthened at the other.

Efficiency of Boiler Seams

How can I figure the efficiency of a boiler seam and why are the roundabout seams of a boiler only single riveted while the others have two or more rows of rivets?

F. C. A.

Riveted seams may fail in several ways, such as tearing the sheet through the line of rivet holes, shearing the rivets, crushing the metal in front of the rivets or a combination of all three. In a correctly designed seam the resistance of the rivets to shearing and the plate to tearing would be equal and the efficiency of the joint is that per cent. of the sheet along the outer row of rivets that remains after deducting the diameter of the rivet holes, and is expressed by the formula

$$\frac{P-d}{P} = \textit{efficiency of joint},$$

in which P equals pitch of rivets and d equals diameter of rivet hole. The circumferential seam is single riveted only, because under no circumstances can the force tending to rupture this seam exceed one-half that brought to bear on the longitudinal one, and with through braces and tubes supporting the heads there is no strain from pressure at all on them.

Engine Efficiency in B.t.u.

How is the efficiency or economy of an engine expressed?

D. E. W.

It should be measured and expressed by the ratio between the B.t.u. consumed and the power developed. If 1,000,000 B.t.u. per hour are consumed in developing 300 horsepower the efficiency of the engine is 7.6 per cent.

Power Requirea by Air Pump

How can I calculate the power needed to operate the air pump of a jet condenser?

J. B.

The work of the ordinary jet-condenser air pump consists in lifting the injection water from the bottom of the air-pump cylinder to the overflow, compressing the entrained and dissolved air from the pressure due to the vacuum to that of the atmosphere, delivering it with the water and overcoming the friction of the machine.

Stress on Staybolts

With ⅞-inch iron staybolts pitched 5 inches apart in one direction and 6 inches apart in the other, what would be the allowable working pressure?

W. A. D.

Pitched 5x6 inches, each bolt would support 30 square inches. The allowable stress on staybolts is 6500 pounds per square inch of cross-sectional area. The cross-section of a ⅞-inch staybolt at the root of the thread is 0.46 square inch and at 6500 pounds tension per square inch would support

$$0.46 \times 6500 = 2990$$

pounds. As this allowable pressure is distributed over 30 square inches, the pressure on each inch would be 99.6 pounds.

Comparative Engine Economy

Of two engines, one having a piston stroke of 24 and the other 36 inches, which would operate the more economically when carrying the same load with the same steam pressure and piston speed?

S. B. R.

If the clearance in both engines is the same, the percentage of clearance would be less in the engine with the longer stroke, and the loss from clearance would be less. The engine with the longer stroke would use slightly less steam than the other.

A Question of Governors

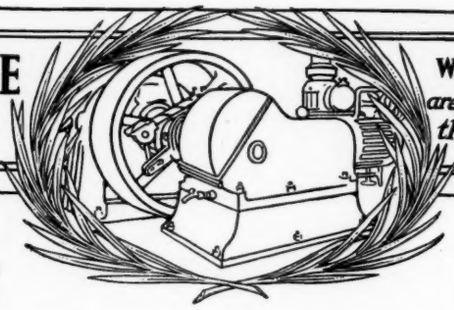
I am running an engine of the slide-valve type built about thirty years ago and equipped with the old-fashioned fly-ball governor.

The engine is running about 110 to 130 revolutions per minute and the governor does not regulate the speed between no load and full load at all satisfactorily. No provision is made for the safety of the engine or plant should the main or governor belt break. I wish to reduce the speed to about 100 revolutions per minute and maintain that speed as near as possible with a fluctuating load. Do you think under the circumstances it would be advisable to try and repair the governor so it would work satisfactorily, or buy a new one?

F. L. S.

If your steam-engine governor is of a standard make such as the Pickering or Gardener its 30 years of use should not have impaired it to any appreciable extent. If, however, it is a homemade affair with a butterfly valve the sooner you throw it away the better; but if made by any of the standard governor makers it should cost but little to put it in first-class working order, and in a condition to control the speed of your engine under all variations of load.

NEW POWER HOUSE EQUIPMENT



WHAT *the* INVENTOR *and the* MANUFACTURER *are* DOING *to* SAVE TIME *and* MONEY *in the* ENGINE ROOM *and* POWER HOUSE

The Garner Ventilating Machine

This machine has been developed to provide a positive means of proper ventilation at all seasons of the year, and at the same time keep the room at a comfortable temperature and avoid dangerous drafts.

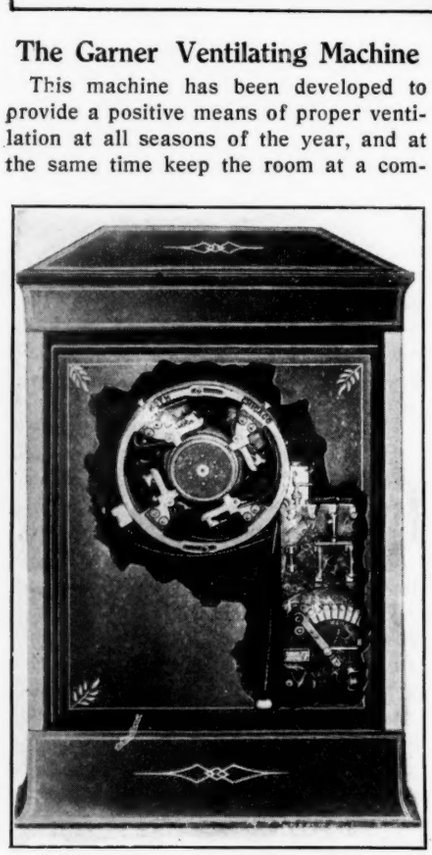


FIG. 1. THE MOTOR

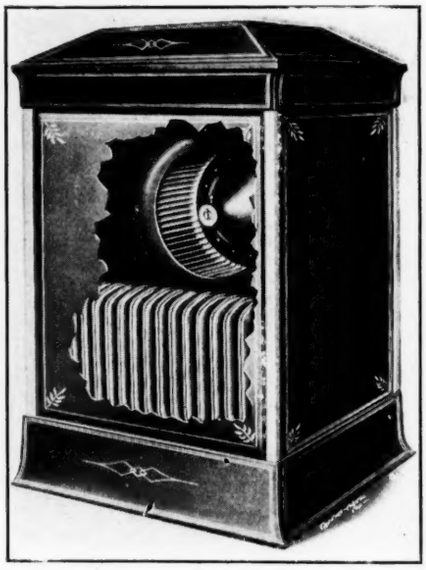


FIG. 2. FAN AND HEATING COILS

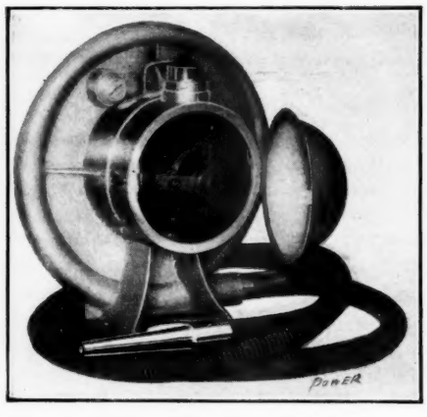
Each machine is a complete ventilating system in itself, as it contains a motor (see Fig. 1), steam coils, to be connected with the steam- or hot-water plant of the building, and a centrifugal fan, Fig. 2. The air is drawn into the machine through a galvanized-iron duct leading from the outside air. After passing over the steam coils the air flows through a very fine wire-mesh screen, to remove the dust and dirt. The current of air is delivered in an upward direction so that the room is filled from the ceiling, thus eliminating drafts.

The machine is durable in construction and ornamental in appearance, the exterior being japanned in a rich maroon color.

The machine is made in two sizes, both the same in principle, but slightly different in shape and mechanical arrangements. They are manufactured by the Garner Ventilating Company, 140 Liberty street, New York City.

Sturtevant Dust Blowing Set

For blowing out the dirt and dust from machinery, around motors, switchboards, shelving and other places difficult or dangerous of access, the B. F. Sturtevant Company, Hyde Park, Mass., has brought out a new portable dust-blowing set. The device is electrically driven and weighs but 55 pounds. It is easily portable and is adapted for attachment to any incandescent-light socket.



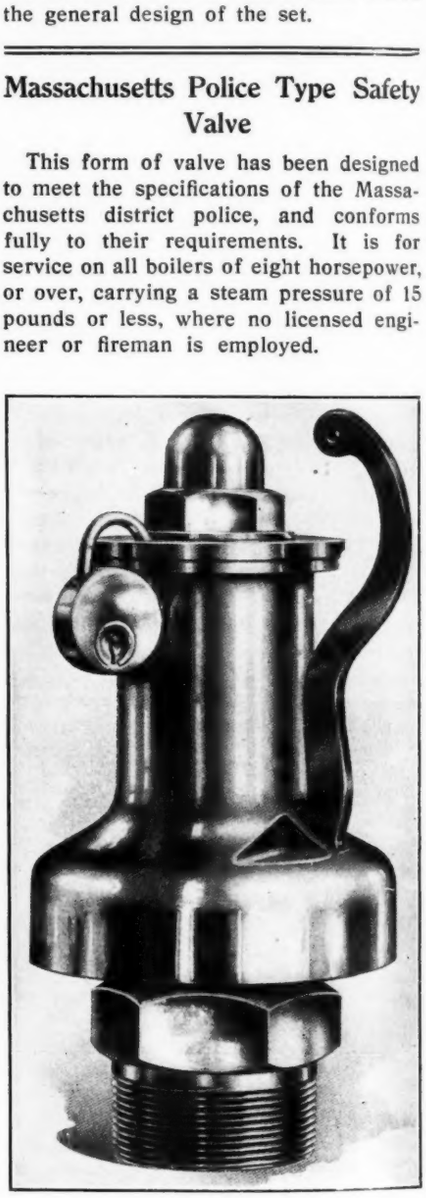
DUST BLOWING SET

The set includes a 12-foot length of 1¼-inch flexible, reinforced air hose, and a 10-inch, tapered, polished-aluminum nozzle. A 20-foot electric-light cord is furnished and in combination with the hose gives a working radius of 32 feet from the lamp socket.

The set may also be used for suction cleaning where a dust collector is not necessary. For this work one end of the hose is attached to the inlet of the fan and the vacuum-cleaner tool fixed to the other end of the hose. The fan will suck the dust through the wheel and discharge it at the outlet or through a hose connected thereto, which may be led out of doors. The illustration shows the general design of the set.

Massachusetts Police Type Safety Valve

This form of valve has been designed to meet the specifications of the Massachusetts district police, and conforms fully to their requirements. It is for service on all boilers of eight horsepower, or over, carrying a steam pressure of 15 pounds or less, where no licensed engineer or fireman is employed.



LOCK-UP SAFETY VALVE

The valve is regularly furnished with lock-up attachment, together with padlock.

While this valve is adapted to all pressures up to 30 pounds, it is set at 15

pounds or less, as 15 pounds is the maximum allowed under the above law. This valve closes sharply without any simmer whatever. The valve is designed to withstand the highest working pressure under which valves of this type are used and also the hard usage often received while being connected to the boiler.

It can easily and quickly be taken apart for grinding or repairs. To accomplish this, the case is unscrewed, using the hexagon nut on the base, which exposes the entire interior of the valve. The lower spring ball, being part of the feather casting, forms a convenient handle when grinding.

The adjustment of the popping point cannot be accomplished without first removing the padlock which secures the cap to the case of the valve. No special tools are required to change the popping point. A monkey wrench and screw driver are all that are needed to connect the valve, adjust or take it apart.

This valve is manufactured by the Consolidated Safety Valve Company, 85 Liberty street, New York City.

"Tread-Kill" Anthracite Dumping Grate

This patented dumping grate, manufactured by M. H. Treadwell Company, 140 Cedar street, New York City, is designed to handle every grade of anthracite coal from the smallest runs of buckwheat, rice and birdseye to the larger sizes, and embodies some unique features of construction.

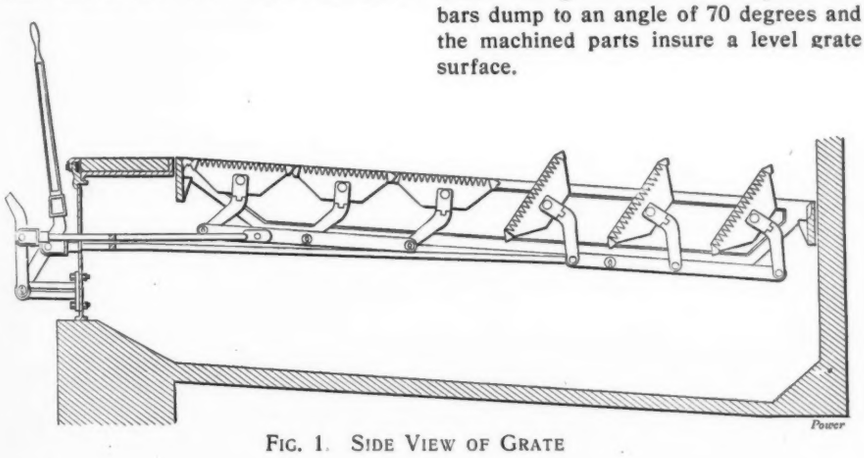


FIG. 1. SIDE VIEW OF GRATE

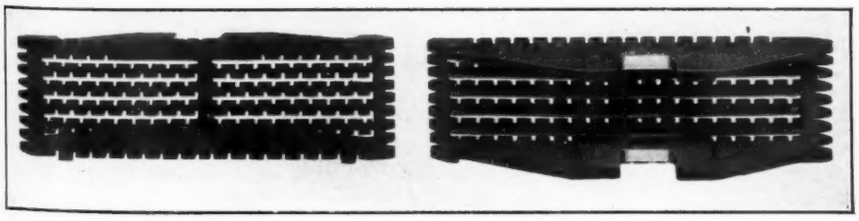


FIG. 2. TOP AND BOTTOM VIEW OF GRATE BAR

In Fig. 2 each bar shows rows of air spaces staggered with respect to each other and to the spaces in adjacent bars. This arrangement of openings, with their even distribution over the entire surface, permits the largest amounts of air space with the least loss of fuel, while the design of the bar permits its manufacture with openings as small as ⅛ inch.

Fig. 2 shows the bar to be of ribbed construction, having a transverse machined slot off center to receive the correspondingly shaped, machined rocking arm. The bars are placed on the rocking arms where, because of the machined fit, they are rigidly and firmly held without the use of bolts or other fastenings. Because of this construction the bars are easy to remove and replace without the use of tools, and without having to go under the grate into the ashpit. The bars dump to an angle of 70 degrees and the machined parts insure a level grate surface.

It will be noted by Fig. 1 that these grates do not butt at the ends, but that they overlap one another, the air space in the end of one bar matching the air space in that of the other. This feature, it is claimed, accomplishes two important purposes, i.e., it fully provides for expansion and does away with the interference at the ends of the dumping-grate bars where they come together; it also eliminates the uneven slots or spaces that would exist between the ends of the bars did they not overlap.

The entire grate area is made up of dumping bars without the introduction of any dead or immovable intermediate bars to retain the ash when the grate is dumped. Thus the entire furnace is cleaned from deadplate to bridgewall.

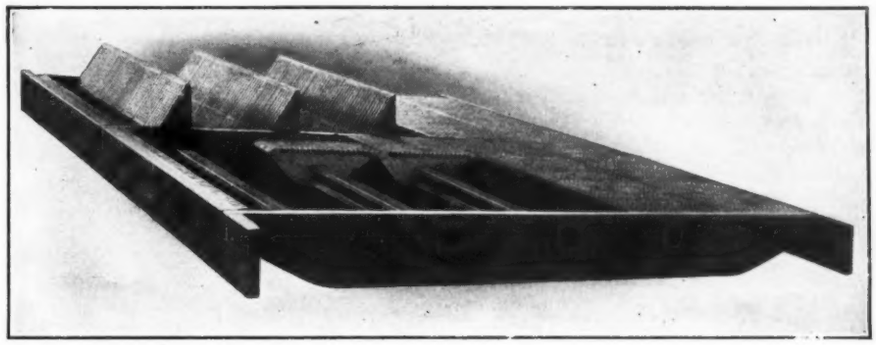


FIG. 3. VIEW OF GRATE WITH SOME OF THE SECTIONS REMOVED

The dumping bars are mounted and arranged so as to support one another and are capable of being dumped in sections at will. It will be noted from Figs. 1 and 3, that the front of the dumping grates underlap the bearing bar, while in the rear they overlap the bearing bar. These bearing bars are provided with air openings which coöperate with the air openings in the ends of the dumping bar.

The mechanism shows simplicity of construction and the absence of small parts. The fittings are made of malleable iron and forgings, the rods for dumping being square in section. The frame of the grate is set in the brickwork and there is nothing under the bars to obstruct the free passage of air. The grate can be applied to any furnace and with any draft system.

Fig. 3 is a photograph of a set of these grates with sections at rest, sections in dumping position and sections removed. It also shows the rocking arms and the means of fastening the journals in the side-carrying bars by use of a wedge-shaped cap which can be removed and replaced by hand.

Hydraulic power mains, aggregating more than 164 miles, are in use in the London district of the London Hydraulic Power Company. Water is distributed from a large station near the Thames under a pressure of 700 pounds per square inch; the total yearly supply is said to be about 900,000,000 gallons. The power is used principally by hydraulic elevators. The number of machines of all classes connected to the power mains increased from 3240 in 1898 to 6368 in 1908.

NEW PUBLICATIONS

THE CORROSION OF IRON AND STEEL. By Alfred Sang. McGraw-Hill Book Company, New York. 127 pages; 5x7¼; cloth. Price, $1 net.

This book is based on a paper read before the Engineers' Society of Western Pennsylvania, at Pittsburg, December 15, 1908, and later published in the *Proceedings*.

The author has not attempted to produce a complete treatise on the subject, but rather has aimed only at the high points in the form of a general résumé. For the benefit of those wishing to go deeper into the subject he has appended a very complete bibliography and gives frequent references in the text, the work being in a great measure a compilation and study of the results obtained by other investigators.

The composition of rust is first taken up and the several theories as to its formation considered; viz., the carbonic acid, hydrogen peroxide and the electrolytic theory.

The structure of iron and steel and its relation to corrosion are discussed. Under this heading is mentioned the fact that the more porous a material is, the more rapidly will it corrode, hard cast iron being less corrodible than soft cast iron of similar composition.

The effect of stress is also cited, corrosion taking place more rapidly in a strained member than in one not strained.

In connection with the subject of the corrosion of steel rails, the interesting fact is brought out that rails subject to considerable vibration rust very little, one case being cited of some rails at Madras, India, which, lying exposed to the air, lost three pounds to the yard, while similar rails in service nearby were not perceptibly affected.

The concluding paragraph deals with the protection of steel by embedding in concrete. As a compendium of the subject suitable for reference, the book should commend itself to those interested in the subject.

"The Weathering of Coal," by S. W. Parr and W. F. Wheeler, is issued by the engineering experiment station of the University of Illinois as Bulletin No. 38. This bulletin embodies the results of weathering tests conducted on carload lots of coal for a period of one year, in the course of which, coal from various mines was exposed in covered bins, open bins and under water. The results are presented in the form of charts which show graphically the losses in heating value resulting from each condition of exposure. Copies of bulletin No. 38 may be obtained gratis on application to W. F. M. Goss, director of the engineering experiment station, University of Illinois, Urbana, Ill.

PERSONAL

Benjamin K. Hough has been appointed by the Wisconsin Engine Company, Corliss, Wis., as Boston sales manager. He will have offices in the Oliver building, Boston, and his territory will comprise the New England States.

Frank E. Hatch, Jr., who has been sales manager for the Auto Ideal Valve Company, New York, is now attached to the Eastern office of the National-Acme Manufacturing Company, Cleveland, at 77 White street, New York.

F. W. Jackson, formerly district manager at Baltimore for the Harrisburg Foundry and Machine Works, Harrisburg, Penn., has been appointed manager for the Chicago district with headquarters at the Marquette building. Mr. Jackson succeeds A. M. Morse, and will have as an associate, Walter Bird, who continues as district engineer. C. H. Israel, formerly assistant engineer of the company at Harrisburg, has been appointed manager for the Baltimore district, with headquarters at 1415 Continental Trust building, Baltimore. George M. Illges, formerly district manager at Atlanta, Ga., has been appointed manager for the St. Louis district, with headquarters at 1415 Chemical building, St. Louis, Mo. He succeeds George D. Pogue and will have associated with him P. A. Haradon, who continues as district engineer. R. B. Hall, Jr., has been appointed manager for the Atlanta district, with headquarters at Empire building, Atlanta, Ga. Walter Castanedo has been appointed manager for the New Orleans district, with headquarters at 1103 Hennen building, New Orleans, La. He succeeds Glenny & Castanedo and will have associated with him R. M. Doherty, who continues as district engineer.

SOCIETY NOTES

The summer meeting of the American Institute of Chemical Engineers will be held at Niagara Falls, June 22, 23 and 24. A line of interesting papers is promised.

A summer meeting of the American Chemical Society will be held in San Francisco, July 12-15. A special train will leave Chicago on the evening of July 4.

The semi-annual meeting of the American Society of Heating and Ventilating Engineers will be held at St. Louis, Mo., on Thursday, June 30, and Friday, July 1, 1910.

The New York section of the American Peat Society will hold an exhibition of peat products, peat machinery, samples of peat, drawings, photographs and anything pertaining to peat, at the rooms of the Chemists' Club, 108 West Fifty-fifth street, New York, on Monday and Tuesday, May 16 and 17, 1910. Any contribution in the way of peat samples, peat products, drawings and photographs with full description will be thankfully received.

All parcels and mail matter should be forwarded to Dr. Charles F. McKenna, 50 Church street, New York.

On Tuesday evening, May 17, Prof. Charles A. Davis, of the United States Geological Survey, will deliver a paper on "Our Peat Bogs a Valuable Asset."

Exhibit Hall for Accident Prevention

An exhibit hall for devices to prevent accidents has just been engaged in the Engineering Societies' building, by the American Museum of Safety. This will constitute a permanent exhibition, free to the public, of safeguarded machines in operation, models, charts and photographs. No exhibit will be displayed that has not been approved by the Board of Approval of Exhibits. There will be no charge for space, but a plan of each installation must be submitted in advance to the director of the museum. Each exhibit will be accepted as a loan for one year, then to be replaced by others if substantial improvements have been made. The museum assumes no responsibility for any damage by fire, or loss by theft, and exhibitors showing nonpatented devices or processes do so at their own risk.

The Board of Approval consists of Prof. F. R. Hutton, Philip T. Dodge, Charles Kirchhoff, T. C. Martin and W. H. Tolman.

All applications for space should be sent to the director at the museum, 29 West Thirty-ninth street, New York City.

Large Mixed-flow Turbine for Illinois Steel Works

In connection with the notable results achieved with low-pressure turbines at the plant of the Interborough Rapid Transit Company of New York, and reported at the March meeting of the American Society of Mechanical Engineers, it is interesting to note that a mixed-flow Curtis turbine of 8000 kilowatts rated capacity, the largest of its type ever built to date, is being installed at the South works of the Illinois Steel Company, South Chicago. The turbine is a three-stage machine and is practically identical, except in size, with those installed at New York, with the addition of a series of live-steam nozzles by which the load may be economically carried in case of failure of the exhaust-steam supply.

The reciprocating engines to be used in connection with this machine have

been altered to make them conform to this class of operation. Condensing facilities are exceptionally good and all conditions are favorable to this type of apparatus. An elaborate series of tests will be run shortly and it is expected that on account of its larger size and the favorable conditions, this unit will show a considerable improvement over the performance of the New York installation.

Large Repair Work on the Isthmus

The largest piece of repair work done on the isthmus by the thermit process, says the *Canal Record,* was recently completed at the Gorgona foundry. It consisted of lining and reinforcing the casing of one of the 20-inch centrifugal pumps from a suction dredge at work on the hydraulic fill of the Gatun dam. This casing had been worn through in several places, and over a large part of its circumference had been abraded to the merest shell. Over 700 pounds of thermit was used on the whole casing, and in one cast, 340 pounds was ignited, this being the largest single cast yet made. On account of the extra reinforcement given a thin part of the casing, the shell, as repaired, is stronger than it originally was. This is only one of several similar repairs made to centrifugal-pump casings.

State Conventions

POWER has written to the secretaries of the several State associations of the National Association of Stationary Enneers requesting particulars regarding their conventions for 1910. Up to the time of going to press the associations of Indiana, Texas and West Virginia have not replied. Following are the dates and places of the annual meetings of the State associations from whom we have heard:

Iowa, at Waterloo, May 5, 6 and 7.

Illinois, at Moline, May 21.

California, at Los Angeles, May 23 to 28.

Pennsylvania, at Scranton, June 3 and 4.

New Jersey, at Jersey City, June 4.

Colorado, at Denver, June 10.

Kentucky, at Hopkinsville, June 10 and 11.

New York, at Buffalo, June 10 and 11.

Ohio, at Hamilton, June 16, 17 and 18.

Wisconsin, at Oshkosh, June 17, 18 and 19.

Connecticut, at New Haven, June 24 and 25.

Massachusetts, at Lowell, July 7, 8 and 9.

Michigan, at Kalamazoo, July 21, 22 and 23.

Canadian Association of Stationary Engineers at Berlin, Ont., July 26, 27 and 28.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c each Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

AUTOMATIC ROTARY ENGINE. Homer A. King, Colton, Cal. 953,206.

ELASTIC-FLUID TURBINE. Elihu Thomson, Swampscott, Mass., assignor to General Electric Company, a Corporation of New York. 953,241.

MOTOR. William E. Snaman, Pittsburg, Penn. 953,444.

ENDLESS WATER-POWER PADDLE MOTOR. Alexander J. Beelman, Jr., Westwego, La. 953,455.

ELASTIC-FLUID TURBINE. Raymond N. Ehrhart, Pittsburg, Penn., assignor to the Westinghouse Machine Company, a Corporation of Pennsylvania. 953,521.

ELASTIC-FLUID TURBINE. Jonathan S. Green, Pittsburg, Penn., assignor to the Westinghouse Machine Company, a Corporation of Pennsylvania. 953,526.

FLUID-PRESSURE TURBINE. Conrad Regenbogen, Manchester, Eng., assignor to the Westinghouse Machine Company, a Corporation of Pennsylvania. 953,552.

BOILERS, FURNACES AND GAS PRODUCERS

STEAM BOILER FURNACE. Patrick Doran, Quebec, Quebec, Canada. 953,023.

LIQUID-FUEL BURNER. William F. Goodwin and Joseph C. Low, San Francisco, Cal. 953,136.

HYDROCARBON BURNER. John C. Kenmonth, Los Angeles, Cal. 953,147.

STEAM BOILER. Charles H. Fox, Cincinnati, Ohio. 953,166.

MEANS FOR CONTROLLING FUEL SUPPLY IN STEAM-GENERATING SYSTEMS. Hermann Lemp, Lynn, Mass., assignor to General Electric Company, a Corporation of New York. 953,212.

CRUDE-OIL BURNER. Mansford W. Gottschall, Frederick, Okla. 953,380.

FURNACE. Herman A. Poppenhusen, Chicago, Ill. 953,396.

HYDROCARBON BURNER. Louis A. Sherman, Detroit, Mich. 953,441.

POWER PLANT AUXILIARIES AND APPLIANCES

PRESSURE REGULATOR. Heinrich Kruger, Berlin, Germany. 953,040.

SAFETY VALVE. Harry C. McCarty, Williamsport, Penn. 953,052.

HOSE COUPLING. Howard L. Ruland, Cincinnati, Ohio. 953,061.

STOP COCK. George T. Stark, Louisville, Ky. 953,067.

VALVE. William Nelson and Charles O. Churchill, Binghamton, N. Y., assignors to the Georgian Manufacturing Company, Binghamton, N. Y., a Corporation of New Jersey. 953,100.

FOLDING BOX. Frederick G. Fischer, New Haven, Conn. 953,132.

APPARATUS FOR DISCHARGING EXCESS EXHAUST GASES FROM MOTORS WORKING ON A CLOSED CYCLE. George F. Jaubert, Paris, France. 953,146.

SPEED-CONTROLLING APPARATUS. Knud E. Winge, Copenhagen, Denmark. 953,164.

FLUID-PRESSURE GOVERNOR. George Macloskie, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. 953,213.

AUTOMATIC VALVE. William E. Dixon, Chicago, Ill. 953,260.

ROD PACKING. Thomas A. Johnston, Chadron, Neb., assignor of one-fourth to Thomas L. Finley, Long Pine, Neb. 953,271.

ELECTRICAL APPARATUS AND APPLICATIONS

ALTERNATING-CURRENT MOTOR. Hans Alexander, Berlin, Germany, assignor to General Electric Company, a Corporation of New York. 953,018.

ELECTRIC SWITCH. Frank E. Case, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. 953,021.

AUTOMATIC SWITCH MECHANISM. Alfred C. Griscom, New York, N. Y. 953,028.

TRANSFORMER FURNACE. Eugen A. A. Gronwall, Axel R. Lindblad and Otto Stalhane, Ludvika, Sweden. 953,030.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City. Spring meeting at Atlantic City, May 31 to June 6.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff, Denver, Colo.; sec. and treas., Frank M. Tait. Association York. Next annual convention, St. Louis, Mo., May 23-28.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U .S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railway, Cleveland, O.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., L. B. Stillwell; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., William G. Snow; sec., William M. Mackay, P. O. Box 1818, New York City. Next semi-annual meeting, St. Louis, Mo., June 30 and July 1, 1910.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August 2-5, 1910.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next convention, Philadelphia, Pa., June 6-10, 1910.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio. Next meeting, Cincinnati, May 19 and 20, 1910.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. E. Brown; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Niagara Falls, Canada, May 24-27, 1910.

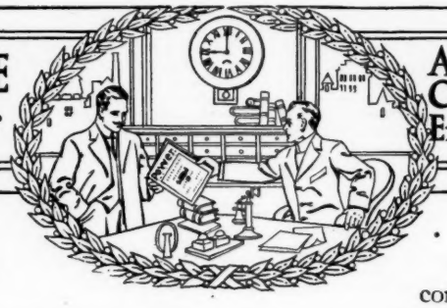
INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee. 606 Main St., Peoria, Ill. Next convention, Denver, Colo., September, 1910.

NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., A. C. Rogers, Toledo, O.; sec. and treas., D. L. Gaskill, Greenville, O. Next annual meeting at Toledo, O., May, 1910.

MOMENTS WITH THE Advertising Editor



A Department for Subscribers Conducted by the Business End of Power and the Engineer

George O. Green runs a power plant 'way down in the wilds of South America.

He can't drop into some other fellow's plant and talk shop; no chance for him to swap experiences with brother engineers; he's a hundred miles from any other mechanical man.

Yet he is in just as close touch with the world of power plant engineering as any other reader of this paper, and much closer than many a non-reader living in the United States.

Read what he says about it:

ECUADOR, S. AMERICA, Feb. 23rd, 1910.

"POWER," New York.

Dear Sir:

For some reason I have not received a January 4 number of POWER. As I have my copies bound each year I should like to have the missing number sent to me.

As I am the only mechanic within a radius of one hundred miles of where I am living, you can form some idea of how valuable POWER is to me in keeping me in touch with what is going on in the engineering world. *When I want any apparatus I always specify articles advertised in* POWER, *and I have not once been disappointed in the quality.*

POWER has a very precarious journey before it reaches me. From New York City it goes to Colon, by steamer; from Colon to Panama, by rail; from Panama to Guayaquil, by steamer, where it is transshipped to a little 50-ton steamer and carried to a place called Station Rosa. It then makes the acquaintance of mule transportation, and at this time of the year (the wet season), it takes three days to go 45 miles. I missed but two copies of POWER last year, which is wonderful considering the journey.

You can imagine what a task it is to bring a 45-kilowatt generator into this neck in the woods. The fields came in sections and the armatures in parts.

Yours truly,

GEORGE O. GREEN.

Read that sentence over again where he says. "And when I want any apparatus I always specify articles advertised in POWER, and I have not been disappointed in the quality."

Marooned, practically, with mules as the final means of transportation, Mr. Green buys the goods advertised in these pages *and is never disappointed.*

We have told you time and again that the goods of manufacturers who continually advertise in these columns are worthy of confidence.

And we have told you *why.*

Here is a glittering example to prove our contention that it *pays* to read advertisements and buy advertised goods.

Certainly if our advertisers were unscrupulous they could ship as pretty a box of lemons as ever was foisted on a confiding man to that far-off republic.

But they are not built that way. We venture to say that they used extraordinary care to see that Mr. Green's orders were filled right.

Certainly the text of the advertisements rang true or Mr. Green would not write, "And I have not been disappointed."

The reasons are plain. The advertiser is continually in the limelight. He makes definite statements about his product and *prints* them. They go on record. He has to live up to them.

A lie lurks in dark corners—Truth gets into the middle of the brightest highway and says, "Here I am; do your damnedest."

And advertising these days *is* truth. Even if you deny that the advertiser has a natural tendency in the direction of truth you'll have to admit that his business acumen keeps him in the straight and narrow path, because anything else doesn't *pay.*

Building a business through the power of advertising takes time. The beginning is an investment—the foundation.

By the time the superstructure begins to rear upward the untruthful advertiser has been found out and his money is a total waste.

The crook and the near-crook know this—the past is strewn with wreckage. So they avoid publicity as a hobo shuns soap.

We know that the things advertised in this paper represent the *best* in their respective lines. Herein is a *selected list* of goods that are *right* for your purposes.

You needn't step outside to find what you want. This is your market-place. It comes right to your door every week.

It's time to shop.